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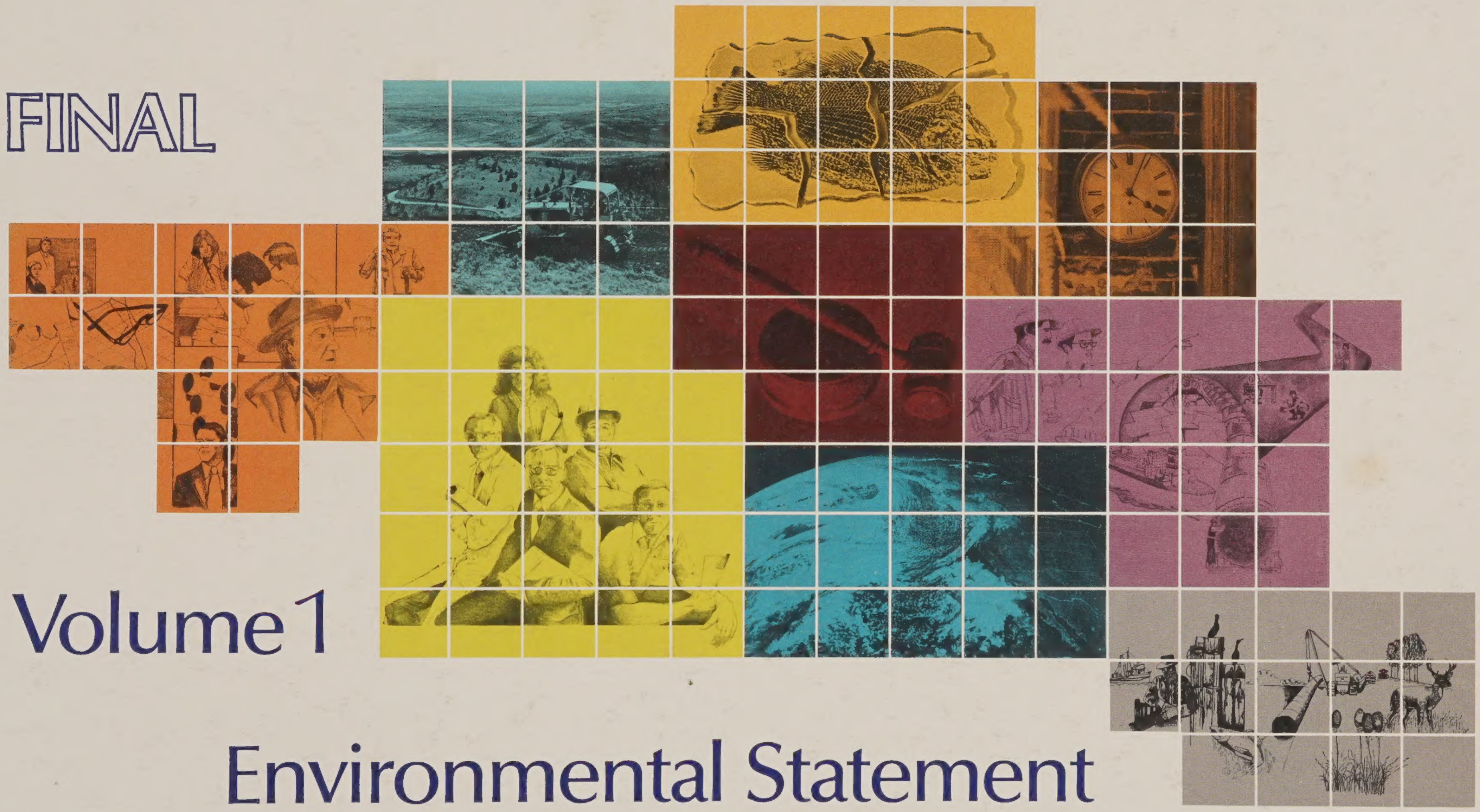

Volume 1

Environmental Statement
Crude Oil Transportation Systems

Proposed by: NORTHERN TIER PIPELINE COMPANY
NORTHWEST ENERGY COMPANY
KITIMAT PIPE LINE LTD.
TRANS MOUNTAIN OIL PIPE LINE CORPORATION

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FINAL
ENVIRONMENTAL STATEMENT

CRUDE OIL TRANSPORTATION SYSTEMS
(Proposed under Public Law 95-617, the
Public Utility Regulatory Policies Act of 1978)

NORTHERN TIER PIPELINE COMPANY
NORTHWEST ENERGY COMPANY
KITIMAT PIPE LINE LTD.
TRANS MOUNTAIN OIL PIPE LINE CORPORATION

Prepared By
Bureau of Land Management
U.S. Department of the Interior

Arnold E. Petty
Acting Director, Bureau of Land Management

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The Crude Oil Transportation Systems Final Environmental Statement is divided into four volumes plus a separate Summary:

Volume 1 contains a description of each of the four Title V proposals and a description and analysis of the proposed Northern Tier Pipeline Company system.

Volume 2 contains a description and analysis of systems proposed by Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation. A summary of the four Title V proposals is presented.

Volume 3 contains alternatives to each of the four systems and public comment on the draft Environmental Statement. Environmental statement team responses are included. Glossary and References.

Volume 4 contains maps relating to each of the four proposals.

Volume 1 contains:

For all Title V applicants:

- Chapter 1 — Descriptions of the Proposals

For Northern Tier Pipeline Company:

- Chapter 2 — Description of the Environment
- Chapter 3 — Environmental Impacts of the Proposal
- Chapter 4 — Mitigating Measures Not Included in the Proposal
- Chapter 5 — Any Adverse Impacts that Cannot Be Avoided Should the Proposal Be Implemented
- Chapter 6 — The Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity
- Chapter 7 — Irreversible and Irretrievable Commitment of Resources

Summary

Draft ( )   Final (x)   Environmental Statement

Department of the Interior, Bureau of Land Management

1. Type of Action   Administrative (x)   Legislative ( )

2. Brief Description of Action

Public Law 95-617, the Public Utility Regulatory Policies Act of 1978 (PURPA), provided for the submission of applications for systems capable of transporting Alaskan and foreign crude oil to the northern tier and inland states. It also provides a means for the President to choose between competing applications. This Environmental Statement addresses four specific proposals which have been filed for consideration under the provisions of Title V of PURPA, to construct and operate a crude oil transportation system. The proposals are from Northern Tier Pipeline Company, Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation.

Northern Tier Pipeline Company proposes port and onshore storage facilities at Port Angeles, Washington, and a 1,491-mile pipeline system extending to Clearbrook, Minnesota. Throughput capacities would be 709,000 barrels per day initially and 933,000 barrels per day ultimately. The system would be designed to supply an additional 350,000 barrels per day to existing refineries in the Puget Sound Area.

Northwest Energy Company proposes port and onshore storage facilities at Skagway, Alaska, and a 710-mile pipeline system extending to Keg River, Alberta. The first 14 miles of the pipeline system would be in Alaska, with the remaining 696 miles in Canada. Throughput capacities would be 530,000 barrels per day initally and 750,000 barrels per day ultimately. From Keg River, crude oil would be delivered through existing systems to the northern tier states.

Kitimat Pipe Line Ltd. proposes port and onshore storage facilities at Kitimat, British Columbia, and a 753-mile pipeline extending to Edmonton, Alberta. Throughput capacities would be 450,000 barrels per day initially and 900,000 barrels per day ultimately. From Edmonton, crude oil would be delivered through existing systems to the northern tier states.

Trans Mountain Oil Pipe Line Corporation proposes port and onshore storage facilities at Low Point near Port Angeles, Washington, and an 823-mile pipeline system extending to Edmonton, Alberta. The first 148 miles of the pipeline system would be in Washington with the remaining 675 miles in Canada. Throughput capacities would be 500,000 barrels per day initially and 630,000 barrels per day ultimately. From Edmonton, crude oil would be delivered through existing systems to northern tier states.

The proposals submitted by the latter three applicants would require the expansion of existing pipeline systems in Alberta. In order to provide crude oil to Montana refineries, approximately 70 miles of pipeline would have to be constructed from Edmonton south to Rimbey, Alberta, to tie into the Rangeland Pipeline.

3. Summary of Environmental Impacts: Impacts of each of the four proposals would be substantially the same, varying with the resources encountered, size of project, and location.

Impacts associated with the Kitimat Pipe Line Ltd. proposal were not analyzed in detail, but would be expected to be similar to those of the other proposals.

Impacts on United States resources associated with the Northern Tier Pipeline Company proposal would extend over the greatest geographical span (1,491 miles); those associated with the Trans Mountain Oil Pipe Line Corporation proposal would extend over 148 miles; and those associated with the Northwest Energy Company proposal would extend over 14 miles.

Significant impacts by all proposals would include degradation of air quality, losses to marine resources should an oil spill occur, and loss of life and property should a fire or explosion occur. Other impacts would include loss of fish and wildlife habitat, degradation of water quality, disruption of transportation and utility networks, greater demand for housing and community goods and services, changes in land use and visual quality, and loss of cultural resources during construction.

Significant beneficial economic impacts would accrue in the form of additional local employment opportunities, increased tax revenues, and expenditures for labor and materials.

4. Alternatives Considered

   A. No action

   B. Delayed action

   C. Northern Tier Pipeline Company Alternatives

   D. Northwest Energy Company Alternatives

   E. Kitimat Pipe Line Limited Alternatives

   F. Trans Mountain Oil Pipe Line Corporation Alternatives

   G. Other crude oil transportation systems

   H. Other Alternatives and Conservation

5. Comments have been received from federal, state, and local entities, and others who received copies of the draft Environmental Statement, as shown by an asterisk on the attached list.

6. Date Statement Made Available to EPA and the Public

   Draft Statement: January 11, 1979

   Final Statement:

Organizations which Received a Copy of Draft Environmental Statement:

(*Denotes comments were received on the DES.)

Federal Agencies

Department of the Interior*
  Bureau of Indian Affairs*
  Bureau of Mines
  Bureau of Reclamation*
  Fish and Wildlife Service*
  Geological Survey
  Heritage, Conservation, and Recreation Service*
  National Park Service*
Advisory Council on Historic Preservation*
Department of Agriculture*
Department of Commerce*
Department of Defense*
Department of Energy*
Environmental Protection Agency*
Department of Health, Education and Welfare*
Department of Housing and Urban Development*
Department of Labor
Interstate Commerce Commission
Great Lakes Basin Commission
Ohio River Basin Commission
Missouri River Basins Commission
Pacific Northwest River Basins Commission
Souris-Red-Rainy River Basins Commission
Upper Mississippi River Basin Commission
Office of Economic Opportunity
Old West Regional Commission
Department of State
Department of Transportation*
Water Resources Council

Indian Tribes

Confederated Salish and Kootenai Tribes of the Flathead Reservation
Coeur de'Alene Tribal Council
Yakima Indian Nation
Lower Elwha Tribal Council
Makah Tribal Council
Muckleshoot Tribal Council*
Nisqually Tribal Council
Point - No Point Treaty Council
Port Gamble Tribal Council
Skokomish Tribal Council
Squaxin Island Tribal Council
Tulalip Tribes*
Fort Peck Tribal Council
Devils Lake Sioux Tribal Council
Three Affilated Tribes Business Council
White Earth Reservation Business Committee

State Clearinghouses

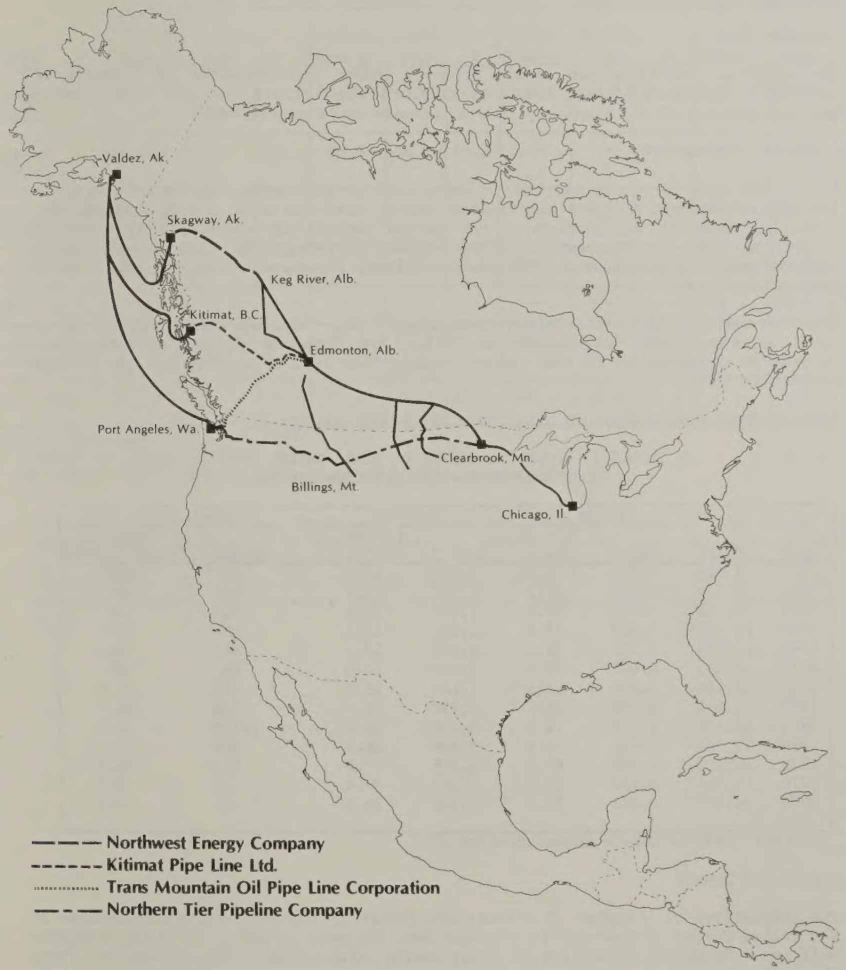
Alaska
Idaho
Minnesota
Montana
North Dakota
Washington

Canada

The U.S. Department of State has transmitted the Environmental Statement to interested agencies and the government of Canada.

Others: A total of 1,500 copies of the DES were printed. Approximately 100 were retained by BLM for internal use. The remainder were distributed to: cities along the route, counties through which the pipelines propose to pass, 180 libraries in the area, field offices of numerous federal and state agencies, and individuals and organizations that requested copies subject to the remaining supply.

Proposed Crude Oil Transportation Systems



Introduction

Background of this Environmental Statement

On January 11, 1979, a draft Environmental Statement (DES) was issued for a crude oil transporation system as proposed by the Northern Tier Pipeline Company (NTPC). The DES was prepared by the Bureau of Land Management in response to NTPC's application for right-of-way to cross federal lands, filed on April 18, 1977, under Title 1 of the Mineral Leasing Act of 1920, as amended.

During final stages of preparation of the DES, on November 9, 1978, the President signed Public Law 95-617, the Public Utility Regulatory Policies Act of 1978 (PURPA). Title V of PURPA addresses crude oil transporation systems and states three purposes:

1. To provide a means for: (a) selecting delivery systems to transport Alaskan and other crude oil to northern tier states and inland states, and (b) resolving both the crude oil surplus over west coast refinery capabilities and the crude oil supply problems in the northern tier states.

2. To provide an expedited procedure for acting on applications for all federal permits, licenses, and approvals required for the construction and operation of any transporation system approved under this title including the Long Beach-Midland project.

3. To assure that federal decisions with respect to crude oil transporation systems are coordinated with state decisions to the maximum extent practicable.

PURPA provided a time frame for applicants to file for consideration under Title V. This time frame provided an initial application period of 29 days following enactment followed by a 60-day period. During the second period the Secretary of the Interior could accept applications if he determined such acceptance to be in the national interest, and that consideration and review could be completed within the time frame established under Title V.

Northern Tier Pipeline Company, Northwest Energy Company, and Kitimat Pipe Line Ltd., filed applications during the initial application period. The Trans Mountain Oil Pipe Line Corporation filed an application during the second application period. All applications were accepted by the Secretary of the Interior.

The proposals filed by Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation were addressed in the DES as alternatives to NTPC's proposal.

PURPA provides for a Presidential decision as to which, if any, of the proposed crude oil transportation systems shall be approved. This decision is to be based on 16 criteria. The first criterion addresses the environmental impacts of the proposed systems and the capability of those systems to minimize environmental risks resulting from transportation of crude oil.

Upon enactment of PURPA and receipt of applications under this Act from each of the four applicants, the Department of the Interior, after consultation with the Council on Environmental Quality determined that an expansion of the discussion contained in the DES was legally permissible under the National Environmental Protection Act

(NEPA). Thus, it is the intent of this final environmental statement to address the environmental impacts for each proposal in sufficient and comparable detail to provide a basis for a Secretarial recommendation and Presidential decision.

On January 4, 1979, the President signed Executive Order 12114 (EO 12114) which addresses the issue of "Environmental Effects Abroad of Major Federal Actions." This order, paragraph 3-5, states "If major Federal action having effects on the environment of the United States or the global commons requires preparation of an environmental impact statement, and if the action also has effects on the environment of a foreign nation, an environmental impact statement need not be prepared with respect to the effect on the environment of the foreign nation."

EO 12114 did not extend NEPA's application extraterritorial for actions solely within a foreign country. The order does not affect NEPA requirements for proposals or portions of proposals within the United States. Thus, those proposals or parts of proposals within Canada have not been given an in-depth NEPA analysis. However, they have been briefly described to give the reader a full view of the applications described below.

The final Environmental Statement has been structured to accommodate PURPA and EO 12114 in the following manner:

> Chapter 1 has been expanded to include a description of each of the four Title V proposals.
>
> Chapters 2 through 7 cover the material covered in the same chapters in the DES. The discussions in these chapters address only the Northern Tier Pipeline Company proposal.
>
> Chapter 8 addresses the proposals by Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation in a manner similar to chapters 2 through 7. It summarizes all Title V proposals.
>
> Chapter 9 replaces chapter 8 of the January 11, 1979, DES. It discusses alternatives presented by Title V applicants as well as alternatives identified by the Environmental Statement team. This chapter also includes alternatives within each of the four proposals and alternatives that are beyond the scope of these PURPA proposals.
>
> Chapter 10 replaces chapter 9 of the DES. It includes coordination, consultation, public comments on the DES, and responses to the public comments.

A glossary and a reference section appear following the text of the document. A separate document contains the Map Addendum.

While there was an extended comment period of 81 days on the DES, many comments have been received suggesting an extended comment period. Normally, publication of a final ES completes the NEPA 102(2)(C) process. However, because of PURPA Title V applications, and in order to meet public concerns, there will be an additional comment period for the final ES. Comments received on the final ES will be used by the Department of the Interior in preparation of the report to the President. Also, recommendations of federal agencies and comments on those federal agency recommendations by state and local agencies will be circulated to the public for their review and comment. These recommendations and comments will also be used by the Secretary of the Interior in preparation of his report to the President. See notice in Federal Register, Volume 44, No. 100, dated May 22, 1979.

Proposed Action

Purpose

The proposed federal action is the approval and/or recommendation of a system or systems to transport Alaskan and other crude oil to northern tier and inland states and the issuance of all necessary federal permits and authorizations.

Historical Background

During the past 25 years, oil has replaced coal as the leading source of energy in the United States, and now constitutes nearly half the U.S. energy consumption. Declining domestic oil production has caused imports to increase from about 15 percent in 1971 to 44 percent in 1977. Reliance on foreign oil supplies has created national security and balance of payment problems, aggravated since the 1973 rise in world oil prices.

Canadian oil exports to the United States, which had comprised one-third or more of total imports, began to diminish in 1974. The Canadian oil export curtailment program is scheduled to further reduce exports from 166,000 barrels per day in 1978 to zero in 1982.

Table 1 shows developments in U.S. crude oil supply sources.

TABLE 1 CRUDE OIL SUPPLY BY YEAR, UNITED STATES
(Thousands of Barrels per Calendar Day)

		Domestic		Imports		Canadian Imports	
Year	Total	Amount	Percent Total	Amount	Percent Total	Amount	Percent Total Imports
1965	9,040	7,800	86.3	1,240	13.7	NA	NA
1966	9,520	8,300	87.2	1,230	12.9	NA	NA
1967	9,940	8,810	88.6	1,130	11.4	NA	NA
1968	10,390	9,100	87.6	1,290	12.4	NA	NA
1969	10,650	9,240	86.8	1,410	13.2	NA	NA
1970	10,690	9,640	88.0	1,320	12.0	NA	NA
1971	11,140	9,460	84.9	1,680	15.1	755	44.9
1972	11,660	9,440	81.0	2,220	19.0	939	42.3
1973	12,450	9,210	74.0	3,240	26.0	1,109	34.2
1974	12,240	8,770	71.6	3,480	28.4	878	25.2
1975	12,480	8,375	67.1	4,105	32.9	674	16.4
1976	13,419	8,132	60.6	5,287	39.4	437	8.3
1977	14,779	8,211	55.6	6,568	44.4	285	4.3

Source: Federal Energy Administration 1977

Supply and Demand

The projections of a number of authorities (table 2) indicate energy consumption in the United States is expected to increase over the next 20 years, but that petroleum will be a declining proportion of total energy consumption. The differences among the projections are indicative of uncertainties in future energy conditions.

TABLE 2 PROJECTIONS OF UNITED STATES ENERGY CONSUMPTION
(Quadrillions of BTUs)

Source	1980			1985			1990			2000		
	Total Energy	Petroleum	%	Total Energy	Petroleum	%	Total Energy	Petroleum	%	Total Energy	Petroleum	%
Energy Info. Admin.	—	—	—	94.6	43.9	46.4	108.5	48.5	44.7	—	—	—
Dept. of Commerce	—	—	—	88.2	38.1	43.2	—	—	—	116.0	26.1	22.5
Dept. of the Interior	87.1	41.0	47.1	103.5	45.6	44.0	—	—	—	163.4	51.2	31.3
Foster Assoc	—	—	—	93.1	38.8	41.7	107.9	40.9	37.9	122.9 1/	42.3 1/	34.4 1/
WAES, Case C 2/	92.2	39.8	43.2	—	—	—	—	—	—	124.5	39.0	31.3
Arthur D. Little	85.0	41.3	48.6	96.4	45.5	47.2	109.9	48.7	44.3	—	—	—
Exxon Corp.	—	—	—	95.0	44.9	47.2	108.0	46.8	43.3	—	—	—

Source: Department of Energy 1979
1/ 1995 data estimates.
2/ Workshop on Alternative Energy Sources, Case C projections.

Prospective United States crude oil supplies are shown in table 3. The amount of foreign crude supplies will depend upon U.S. demand and the availability of foreign oil. Domestic supplies (shown by area) represent anticipated crude oil production in those areas. See fig. 1 for Petroleum Administration for Defense Districts (PADD). Domestic supplies have recently been increased by Alaskan North Slope (ANS) production.

TABLE 3 FORECASTED CRUDE OIL SUPPLIES, 1980 - 2000
(Thousands of Barrels per Calendar Day)

Area	1980	1985	1990	2000
Domestic	9,877	9,570	10,257	10,620
PADD 2 & 4 1/	1,400	1,280	1,190	1,115
California	1,135	1,250	1,230	1,350
Alaska	1,730	2,105	3.060	2,915
North Slope	1,600	2,000	2,500	2,415
Other Alaska	130	105	560	500
Other domestic 2/	5,612	4,935	4,777	5,240
Foreign	5,790	8,535	9,109	11,546
Total	15,667	18,105	19,365	22,166
Total (Quads) 3/	(33.2)	(38.3)	(41.0)	(46.9)

Source: Department of Energy 1979
1/ See figure 1 for area defined by Petroleum Administration for Defense Districts (PADD) 2 and 4.
2/ Includes natural gas liquids not distributed by area.
3/ Total converted to Quads (quadrillions of BTUs) per year by factor of 472.4 M B/D = 1 Quad per year.

Utilization of Alaskan North Slope (ANS) Production

Efficient utilization of ANS crude is complicated by its location and chemical properties and by the configuration of existing transportation systems and refinery facilities. Crude oils differ in composition, and are not fully interchangeable for refining purposes.

ANS crude oil is rated as a heavy, sour crude which means that it is a low gravity oil containing more sulfur than a so-called sweet crude. Heavy oils yield less gasoline and more residual products such as bunker fuel and asphalt, unless special processes are used. The 1.05 percent sulphur content of ANS crude is above that of 60 percent of the crude currently processed in U.S. refineries, but lower than that in the remaining 40 percent which may have sulphur content ranging up to 4.0 percent (Department of Energy 1979).

Most refineries can process varying proportions of sour crude when mixed with other crude. Processing sour crude alone increases refining costs substantially. For example, a 150,000 barrel per day sour crude refinery is estimated to have an investment of $2,613 per barrel per day versus $1,518 per barrel per day for a 147,000 barrel per day sweet crude refinery and has operating costs twice as high

Northern Tier States, Petroleum Administration for Defense Districts and 1978 Crude Oil Movement

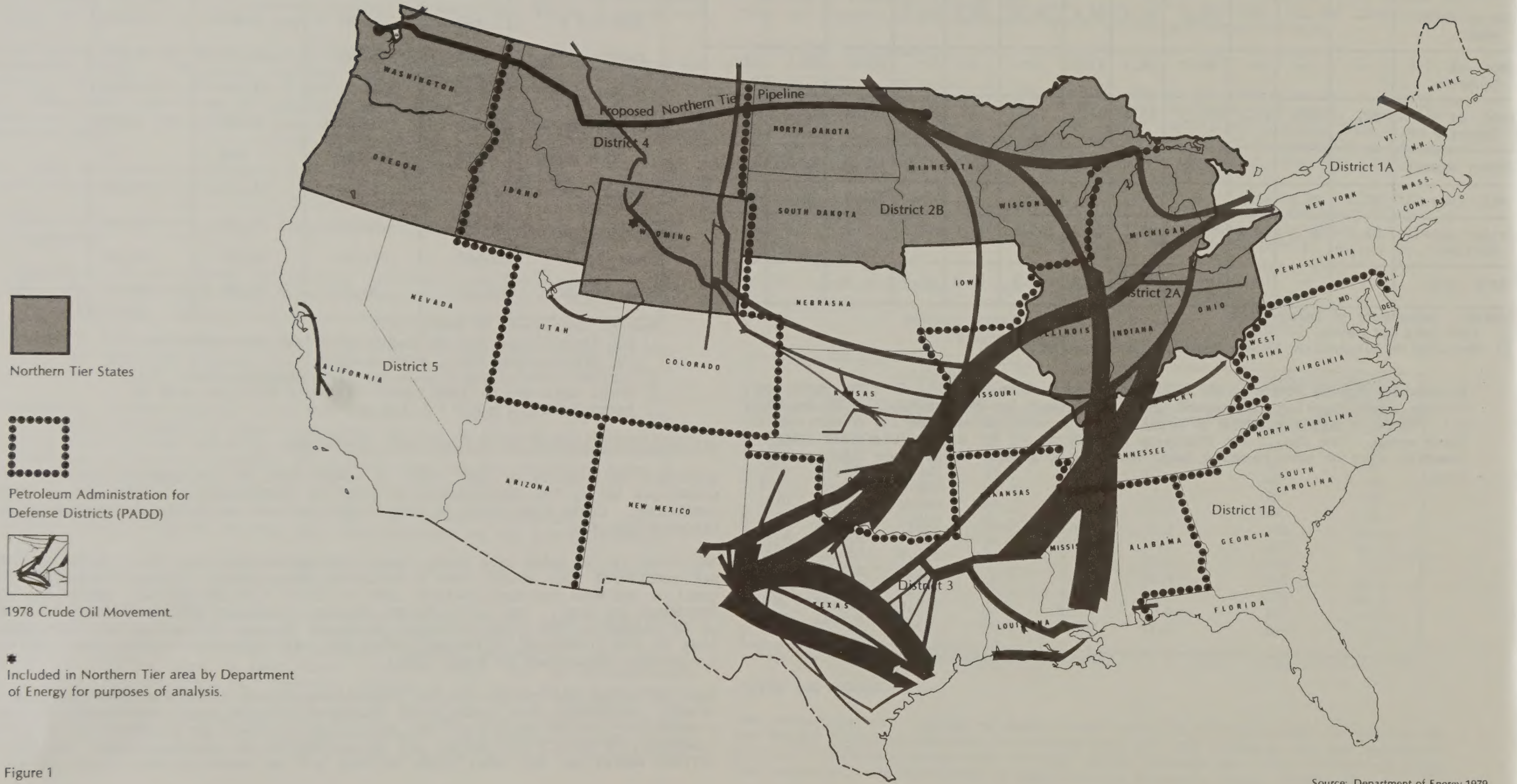


Figure 1

Source: Department of Energy 1979

(Department of Energy 1979). Consequently, efficient utilization of ANS crude depends partly upon the availability of light crudes for suitable mixing purposes.

The amount of ANS crude which can be utilized on the west coast presently is limited by these characteristics. Increased local production from California offshore fields and the Elk Hills reserve is expected to further restrict future utilization of ANS crude. The surplus over west coast refinery capabilities is estimated to be about 500,000 to 600,000 barrels per day in 1978 for 1.2 million barrels per day ANS production, and is expected to rise to about 1 million barrels per day by 1985 (Department of Energy 1979).

The need for replacement oil supplies will increase in the northern tier states since Canadian crude oil exports to these states are not assured beyond 1981. Export levels as recommended by the Canadian National Energy Board are:

1978 - 172 thousand barrels per day (actual)
1979 - 162-172 thousand barrels per day
1980 - 55 thousand barrels per day
1981 - 55 thousand barrels per day
1982 - none

Canadian exports of light crude are scheduled to be terminated in 1981. Heavy crude exports have not been scheduled beyond 1979, but some heavy crude may continue to be available to U.S. refineries. Canadian utilization of a current heavy crude surplus appears to depend upon upgrading a Canadian facility which would convert heavy to light crude at a cost estimated at $4 to $6 per barrel (Canadian NEB 1978).

Northern tier, Rocky Mountain, and midwest regional oil production is declining in spite of new oil discoveries in the Williston Basin and southwestern Wyoming. Anticipated production in this region (identified as PADD 2 and 4) is shown in table 3.

Existing and planned oil transportation facilities into the region are not adequate to meet the expected need for additional supplies. The Department of Energy has developed preliminary estimates of physical deficiencies in supplies to refineries and consumers in the northern tier states based on full use of transportation facilities. The states which would experience these deficiencies include eastern Washington, Montana, North Dakota, Minnesota, Wisconsin, and Illinois.

This document, along with other analyses for the remaining 15 criteria set out in PURPA, will provide a basis for decision as to an acceptable crude oil transportation system. The other analyses are being conducted concurrently by the Department of the Interior and other federal agencies.

TABLE 4 PROJECTED DEFICITS IN NORTHERN TIER STATES
(Thousands of Barrels Per Day)

	1980	1985	1990	2000
Consumer demand				
Average	0	63.7	129.3	320.2
Peaking 1/	51.8	199.5	285.0	777.8
Refinery demand				
90 percent capacity Utilization	109.4	204.2	215.4	214.3
100 percent capacity Utilization	156.6	268.3	375.8	621.2

Source: Department of Energy February 1979

1/ Peaking demand represents 115 percent of average daily demand.

1 DESCRIPTION OF THE PROPOSAL

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MAPS

See Map Addendum

DESCRIPTION OF THE PROPOSALS

1.1 Brief Summation of Proposals

This chapter will describe the proposals presented by four applicants under the provisions of Public Utility Regulatory Policies Act (PURPA) of 1978. Each proposal will be described in terms of construction, operation and abandonment; the proposed sea legs; port and onshore storage facilities; and pipeline system.

Northern Tier Pipeline Company (NTPC)

The Northern Tier Pipeline Company filed application with the Department of the Interior on December 8, 1978, under Title V of the Public Utility Regulatory Policies Act of 1978, to construct and operate a crude oil transportation system from Port Angeles, Washington to Clearbrook, Minnesota.

The fixed-berth port would be located in Port Angeles harbor on Ediz Hook and would be designed to accommodate tankers in the 18,000 to 300,000 dead weight ton class. Tanker traffic would average about 300 port calls per year initially and 395 port calls per year ultimately. The onshore storage facilities would be located on a 242-acre site on Green Point, approximately 6 miles east of Port Angeles, and would include 11 tanks with a total storage capacity of 6 million barrels initially and 18 tanks with a total storage capacity of 10 million barrels ultimately. Two 5.2 mile submarine pipelines would connect the port facility to the onshore storage facility. The pipeline system would consist of 1,491 miles of 40- and 42-inch diameter pipe and would be located entirely within the United States. From the onshore storage facility the pipeline would cross beneath Puget Sound in two segments for a total of 22 miles, proceed generally east through central Washington, the northern Idaho panhandle, central Montana, northern North Dakota, and terminate in northwest Minnesota at Clearbrook. The pipeline would be located adjacent to existing transporation and utility corridors for approximately 500 miles. A 75-foot permanent pipeline right-of-way would be required.

Throughput capacities would be 709,000 barrels per day initially and 933,000 barrels per day ultimately. The pipeline system would be designed to supply an additional 350,000 barrels per day to existing refineries in the Puget Sound area.

Project costs would be approximately $1.2 billion (1978 dollars) for the initial throughput capacity phase and an additional $43 million for the ultimate throughput capacity phase. Construction would require about 2 years.

Northwest Energy Company (NEC)

The Northwest Energy Company filed application with the Department of the Interior on December 8, 1978, under Title V of the Public Utility Regulatory Policies Act of 1978 to construct and operate a crude oil transportation system from Skagway, Alaska to Keg River, Alberta, Canada.

The fixed-berth port would be located at Skagway and would be designed to accomodate tankers up to the 225,000 dead weight ton class. Tanker traffic would average about 206 port calls per year. The onshore storage facility would be located on a 73-acre site approximately 1 mile north of Skagway and would include 8 tanks with a total storage capacity of 4 million barrels. The site is currently being used for petroleum storage. A 3.5 mile pipeline would connect the port facility to the onshore storage facility. The pipeline system would consist of 710 miles of 34- and 36-inch diameter pipe. The first 14 miles would be in Alaska and the remaining 696 miles would be in Canada. From the onshore storage facility the pipeline would proceed in a northerly direction for 14 miles to the Alaska-British Columbia border. It would then proceed generally east, cross the northwest corner of British Columbia, the southern portion of the Yukon Territory, the northeast corner of British Columbia, and terminate in northwest Alberta at Keg River. From Keg River, Alberta, crude oil would be delivered through existing systems to northern tier states.

The pipeline would be located adjacent to an existing railroad right-of-way for approximately 11 miles in Alaska and adjacent to existing transportation and utility corridors for approximately 400 miles in Canada. In Alaska, the permanent pipeline right-of-way would be 45 feet along segments adjacent to the railroad right-of-way and 75 feet along other segments.

Throughput capacities would be 530,000 barrels per day initially and could be increased to 750,000 barrels per day ultimately through the installation of additional pumps and pump stations.

Project costs would be approximately $919 million (1978 dollars) for the inital throughput capacity phase. Approximately $219 million would be required for construction of the United States portion and approximately $700 million for the Canadian portion. Construction would require about 2 years.

Kitimat Pipe Line Ltd. (KPL)

Kitimat Pipe Line Ltd., filed application with the Department of the Interior on December 8, 1978, under Title V of the Public Utility Regulatory Policies Act of 1978 to construct and operate a crude oil transportation system from Kitimat, British Columbia, Canada, to Edmonton, Alberta, Canada.

The floating-berth port would be located near Kitimat, British Columbia approximately 500 miles north of Vancouver, British Columbia, and would be designed to accommodate tankers up to the 320,000 dead weight ton class. Tanker traffic would average about 84 port calls per year initially and 156 port calls per year ultimately. The onshore storage facility would be located in the vicinity of Kitimat and would include five to nine tanks with a total storage capacity of 3 to 5 million barrels. The pipeline system would consist of 753 miles of 36-inch diameter pipe and would be located entirely in Canada. The pipeline would proceed generally east, cross central British Columbia, and terminate in central Alberta at Edmonton. From Edmonton, crude oil would be delivered through existing systems to the northern tier states. The pipeline would parallel existing highways throughout most of the route.

Throughput capacities would be 450,000 barrels per day initially and 900,000 barrels per day ultimately.

Construction costs would be approximately $750 million (1977 Canadian dollars). Construction would require about two years.

Trans Mountain Oil Pipe Line Corporation (TMC)

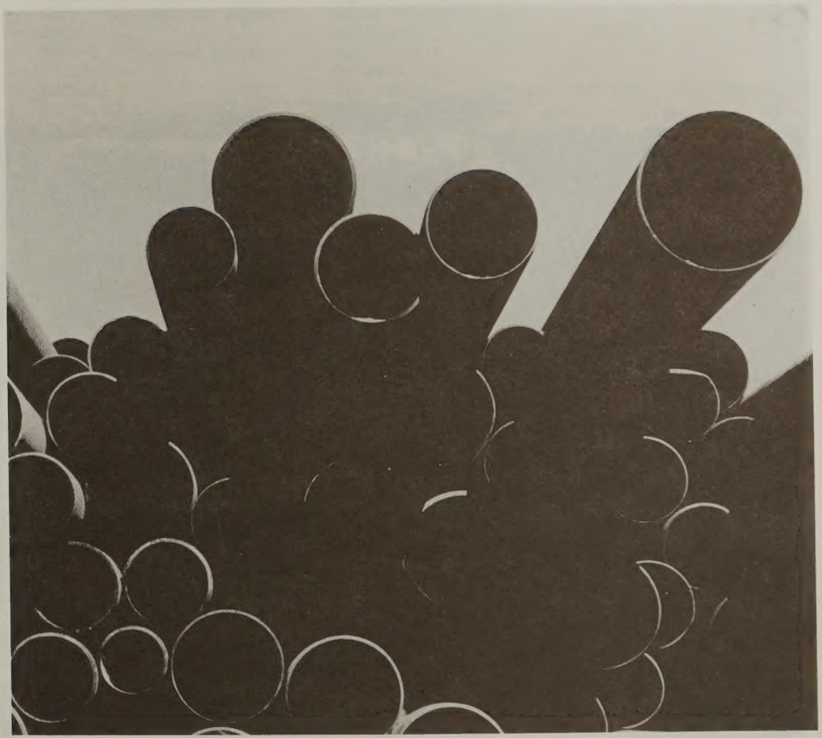
The Trans Mountain Oil Pipe Line Corporation filed application with the Department of the Interior on February 6, 1979, under Title V of the Public Utility Regulatory

Policies Act of 1978 to construct and operate a crude oil transportation system from Low Point, Washington, to Edmonton, Alberta, Canada.

The port would consist of two single point moorings and would be located offshore at Low Point, 18 miles west of Port Angeles, Washington. It would be designed to accommodate tankers up to the 200,000 dead weight ton class. Tanker traffic would average about 205 port calls per year. The onshore storage facility would be located on a 300-acre site at Low Point and would include eight tanks with a total storage capacity of 4 million barrels. Two 2.5 mile submarine pipelines would connect the port to the onshore storage facility. The pipeline system would consist of 823 miles of 30-inch diameter pipe. The first 148 miles would be in Washington and the remaining 675 miles in Canada. From the onshore storage facility the pipeline would proceed east, cross beneath Puget Sound in two segments for a total of 5.5 miles, then proceed north to the Washington-British Columbia border near Sumas, Washington. From the Washington-British Columbia border the pipeline would proceed northeast, cross southeast British Columbia, and terminate in central Alberta at Edmonton. From Edmonton, crude oil would be delivered through existing systems to the northern tier states. The pipeline would be located within an existing right-of-way for 54 miles in Washington. A 60-foot permanent pipeline right-of-way width would be required. The pipeline would follow an existing right-of-way through Canada.

Throughput capacities would be 500,000 barrels per day initially and 630,000 barrels per day ultimately.

Project costs would be $200 million (1979 U.S. dollars) for the United States portion and $383 million (1979 Canadian dollars) for the Canadian portion. Construction would require about 2 years.



Bureau of Land Management

1.2 Proposal of the Northern Tier Pipeline Company

The Northern Tier Pipeline Company (NTPC), a consortium of independent companies, filed an application under PURPA on December 8, 1978, to construct and operate a common carrier crude oil transportation system extending from Port Angeles, Washington, to Clearbrook, Minnesota. The proposal includes fixed berth tanker unloading facilities in Port Angeles harbor and a pipeline system across Washington, Idaho, Montana, North Dakota, and western Minnesota.

The companies' shares are held directly or through wholly owned subsidiaries of:

1. Westinghouse Electric Corporation
2. United States Steel Corporation
3. Burlington Northern, Inc.
4. Western Crude Oil, Inc.
5. MAPCO, Inc.
6. Milwaukee Land Company
7. Butler Associates, Inc.
8. Curran Oil Company
9. Farmers Union Central Exchange, Inc. (CENEX)*

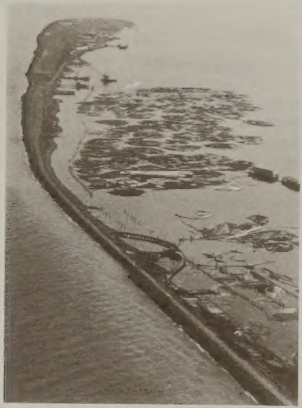
* The Board of Directors of CENEX, on May 31, 1979, approved the purchase of the Companies' shares on previously agreed terms.

The system would be designed with an initial throughput capacity of 709,000 barrels per day and an ultimate capacity of 933,000 barrels per day. The oil would be distributed to intermediate delivery facilities in Montana and North Dakota and the terminal at Clearbrook, Minnesota. The system would be controlled and operated from the onshore storage facility at Green Point, near Port Angeles, Washington.

The NTPC proposal includes provision in its design to enable the system to accommodate an additional 350,000 barrels per day throughput over the initial 66 miles of the pipeline from Port Angeles to the vicinity of Arlington, Washington. This provision is included in the design to provide service to Puget Sound refineries. The facilities that would have to be constructed by NTPC to accommodate the total throughput of 1.283 million barrels per day include a third tanker berth, booster pump and submarine pipeline, seven additional storage tanks at Green Point, additional horsepower at the initial pump station, and a delivery facility with tankage near Arlington. In order for the refineries in the Puget Sound area to utilize the system, some other party would construct a 21-mile long pipeline with associated facilities to connect the NTPC delivery facility near Arlington, to the existing Trans Mountain Pipeline System near Burlington, Washington. NTPC does not propose to construct the modifications at this time. No other party has proposed to construct or operate the connecting pipeline system which would supply the existing Puget Sound refineries. When and if such a proposal surfaces, it would be subject to the application and environmental review requirements of the state of Washington. The potential modifications are described, along with the probable environmental impacts as a possible cumulative impact of the NTPC proposal.

Sea Leg

The principle marine routes serving the proposed pipeline terminal at Port Angeles would originate in Valdez, Alaska; the Mideast; Indonesia; and Latin America.



Ediz Hook, Washington
Site of proposed port facilities
Bureau of Land Management

Location of Proposed Port and Onshore Storage Facilities

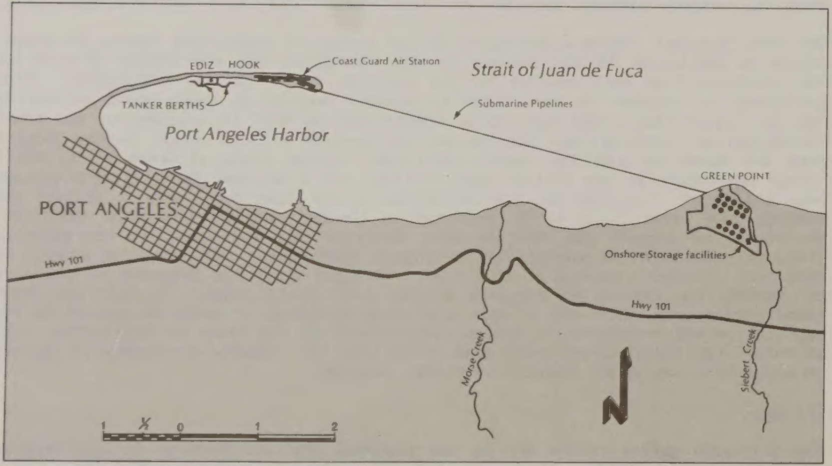
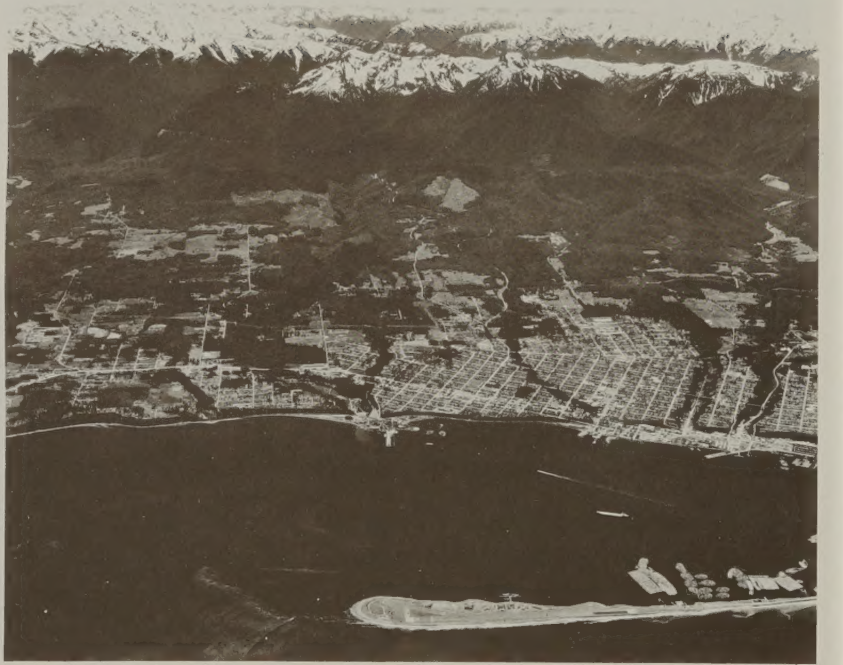


Figure 1.2-1

Bureau of Land Management



Ediz Hook, Port Angeles, and Olympic National Park in background

Northwest Air Photos, Port Orchard, Washington 1974

NTPC has projected tanker sizes, crude oil mix, and port call frequency. Table 1.2-1 provides the company's estimates of source and crude oil mix for the initial system capacity of 709,000 barrels per day. Table 1.2-2 shows the estimated frequency of tanker calls at Port Angeles for the initial capacity and for the ultimate capacity.

TABLE 1.2-1 ESTIMATED SOURCE AND CRUDE OIL MIX
(709,000 bpd throughput)

Crude Oil	Source	Volume Barrels Per Day	Volume Percent
Alaskan North Slope (1.05 percent sulfur)	Alaska	375,770	53
Sweet (0.0 - 0.5 percent sulfur)	Algeria, Indonesia, Libya, Nigeria	56,720	8
Light (0.1-1.15 percent sulfur)	Abu Dhabi, Saudi Arabia, Sarjah U.A.E	92,170	13
Medium (1.16-2.0 percent sulfur)	Iran, Egypt, Qatar, Saudi Arabia, Iraq	184,340	26
	Total	709,000	100

Source: NTPC 1978

TABLE 1.2-2 ESTIMATED FREQUENCY OF TANKER CALLS

Tanker Size Class (dwt)	Number of Port Calls Per Year Initial 709,000 barrels per day	Ultimate 933,000 barrels per day
Alaska North Slope crude oil		
50,000	56	74
70-80,000	102	134
120-130,000	40	53
165,000	16	21
190,000	6	8
Subtotal	220	290
Foreign crude oil		
100-125,000	4	5
150-175,000	26	34
175-200,000	13	17
200-225,000	13	17
225-250,000	12	16
300-327,000	12	16
Subtotal	80	105
Total	300	395

Source: NTPC 1978

Port and Onshore Storage Facilities

The proposed port and onshore storage facilities would consist of a port adjacent to Ediz Hook within Port Angeles harbor, submarine pipelines, and the onshore storage facility near Green Point (see fig. 1.2-1).

Port

The port facility would include two fixed berths, roadway and pipeline trestles connecting the berths to Ediz Hook, booster pumps to assist the ship's pumps while unloading, two submarine pipelines for transferring the crude oil to the onshore storage facility, and support facilities.

The proposed fixed berths would be constructed in an area inside Ediz Hook where water depth is approximately 100 feet. This depth is adequate for tankers of 18,000 to 300,000 dead weight ton class. Dredging would not be required.

Basic structures for each berth would be mooring and breasting dolphins, service platform for placement of unloading arms and piping, ship's access tower, and support facilities. One berth would have two additional breasting dolphins installed to enable smaller tankers in the 18,000 to 80,000 dead weight ton class to use the berthing facilities.

Due to the elevation of the onshore storage facility (120-190 feet), the ship's pumps would be assisted by booster pumps during the unloading operations.

A flow rate of approximately 100,000 barrels per hour per pipeline to the highest tank at the onshore storage facility would be possible.

A surge pressure relief system would be installed on the booster pump platform. The system consists of unloading line fast-acting relief valves and a floating roof, 10,000 barrel tank. This system would reduce pressure surges resulting from rapid and unscheduled shutdown of ship or booster pumps.

Support facilities and services for the port would include controls, communications, electric power supply, fire protection, waste treatment and disposal, bunkering service, potable water supply, oil spill containment and recovery equipment, oil recovery vessel, and tug service. The main control center located at the onshore storage facility would control port operations.

The start-stop functions of the booster pumps would be controlled at the main control center. However, control from berth platforms would also be possible on activation of permissive control circuits by the terminal dispatcher.

Communication systems would include VHF marine radio direct telephone circuits to berth platforms and booster pump platform from the main control center; conventional telephone and UHF radio for communication with the oil recovery vessel, berth, and booster pump platforms; and portable units for personnel in the terminal areas.

Electric power for the booster pump motors along with that required by berthing facilities and booster pump platform auxiliaries would be supplied by the city of Port Angeles. These requirements would include lighting for platform work areas, roadway trestles, personnel trestles, and mooring dolphins. Power for booster pump motors, unloading arms, capstans, cathodic protection system, communications systems, control systems, oil-water separators, and other support facilities would be supplied. These power requirements are shown in table 1.2-3 for both initial and ultimate system capacities.

TABLE 1.2-3 NTPC SYSTEM PORT FACILITY POWER REQUIREMENTS

System Capacity	Peak Demand (Megawatts)	Monthly Kilowatts (Million)	Annual Kilowatts (Million)
Initial (709,000 bpd)	15.6	2.8	33.6
Ultimate (933,000 bpd)	15.6	3.6	43.2

Source: NTPC 1978

Emergency power at the port would consist of an automatically activated diesel-driven generator that would supply power to: unloading arm positioning controls; manifold valves; area lighting, building lighting and utilities; communications equipment; system controls; booster pump motor-operated valves; and capstans.

Although electric motor driven booster pumps would be inoperative during power outages, the emergency generator would supply power to berth facilities and permit unloading to continue at a reduced rate by means of the ships' pumps operating alone.

A seawater, fire protection system with foam capability would be provided at the port. Two diesel engine fire pumps would be installed on a platform with roadway trestle access from shore. Fire mains would be installed along the roadway and pipeway trestles to form a closed loop system. There would be fire hydrants on the berth, booster pump platforms, and trestles. A remote-controlled high capacity water monitor would be provided on the access tower at each berth. Foam monitors would be located on each platform and near each platform on roadway trestles. Portable dry chemical units would be provided on the platforms to control electrical fires. One NTPC-owned fireboat would be in service during tanker unloading operations.

Smoke and heat detectors would be located in all buildings including the booster pump control room and berth operator's shelters. Alarms would sound at the berth and booster pump platforms and at the shore ends of roadway trestles. A warning signal would light up at the main control center at the onshore storage facility.

Runoff and oily waste would be directed to a holding tank on each berth platform and on the booster pump platform. Packaged oil-water separators would be installed on each platform to process holding tank contents. Separator effluent would be discharged into the harbor below mean lower low water level. The oily residue would be injected into crude oil unloading lines for transfer to onshore storage facilities.

Sewage from each berth and booster pump platform would be accumulated in holding tanks and disposed of by commercial septic tank pumpers.

Bunkering would be provided by a fuel oil storage barge having a capacity of approximately 150,000 barrels permanently moored at the barge berth as shown in figure 1.2-2. The storage barge would be supplied with bunker fuel from small tankers or barges which would unload at the crude oil tanker berths. The permanently moored barge would be the only source of bunker fuel available to crude oil tankers while at berth. The fuel oil storage barge would have segmented storage for delivery of bunker C fuel, No. 2 diesel, and a blend of bunker C and No. 2 diesel. The fuel storage barge would be supplied by tankers primarily from California.

Tugs and line handling launches associated with the terminal operations would be supplied by private service companies operating in Puget Sound and Port Angeles areas. Ordering and payment for tug services would be the responsibility of the ships. Service companies would have fuel supplies at their base of operation. NTPC's combination line-handling, oil recovery vessel would obtain diesel fuel from suppliers at Port Angeles.

Each berth platform would be served by two separate water supply systems: seawater for fire protection and potable water for stevedore's facilities and ship's tanks. Potable water would be supplied by a pipeline connecting each berth service platform to a city water main serving Ediz Hook. These water lines would be carried on pipeway or roadway trestles.

A storage area for oil recovery and cleanup equipment would be near the tanker berthing area. Equipment to be kept on hand would be determined during the development of the spill contingency plan.

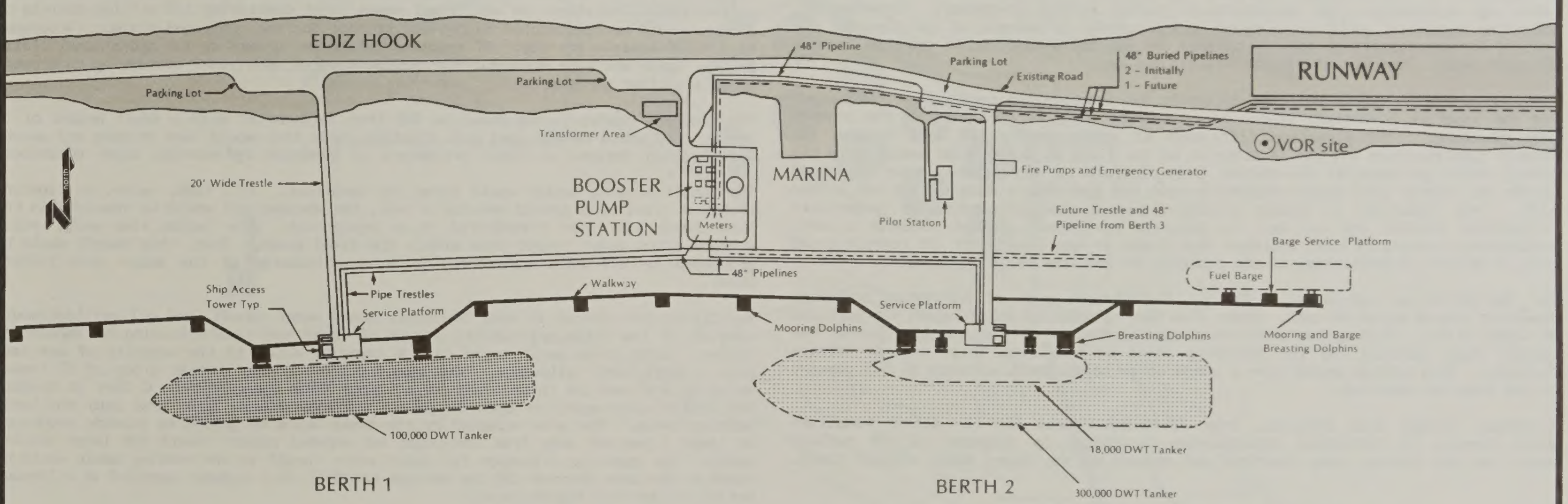
Manpower for emergency operations would be obtained from the operating staff plus fire departments and cleanup contractors. Detailed response actions would be in the spill contingency plan.

Semipermanent floating oil booms would be located in front of mooring dolphins and under berth service platforms and would extend between the extreme mooring dolphins. Retractable booms would be capable of extending around the outside of the ship. The ends of the retractable booms would be connected to the fixed boom enclosing the ship and be held in position off the hull by floating braces.

Small quantities of oil contained within the boom system would be recovered by a floating oil skimmer swung overboard from the service platform by means of a davit, crane, or similar gear. Collected oil would be transferred to the oily waste sump on the berth service platform and pumped into the main cargo unloading line.

For a more dispersed spill, NTPC would provide a skimmer-recovery vessel. For a large catastrophic spill, the services, equipment, and expertise of the Clean Sound Cooperative would be utilized. Major petroleum operators in the area are members of the Seattle-based cooperative. NTPC would become a member of the cooperative and make capital contributions as required.

The NTPC skimmer-recovery vessel would double as a line handling launch and would be permanently stationed at the terminal. This vessel would also be used for pulling the floating outer boom into place around the ship after docking and before unloading. Additional line handling launches would be available on contract.



Proposed Port

Not Drawn to Scale

Source: Northern Tier Pipeline Company

Figure 1.2-2

Submarine Pipelines

Two submarine pipelines are proposed to connect the booster pump platform adjacent to Ediz Hook to the storage tank filling line network at the onshore storage facility. These lines would be 5.2 miles in length and either 48 inches or 52 inches in diameter. The diameter would be selected on completion of design studies. Tentative location of submarine lines is shown in figure 1.2-1. Final location would be determined following completion of oceanographic and bottom sediment studies.

The capacity of the submarine pipelines would allow a reduction in tanker turnaround times and accommodate wide variations in tanker arrival frequency. Consequently, submarine pipelines would be inactive approximately 74 percent of the time for the initial design capacity of 709,000 barrels per day and 66 percent of the time for the ultimate design capacity of 933,000 barrels per day.

The leak detection system would be different for inactive and active line conditions. For the inactive condition, static line pressure would be monitored at the booster pump platform. The elevation difference of approximately 100 feet between the booster pump platform and the termination of the lines at Green Point would cause the normal static pressure at the booster pump platform to vary between about 36 and 40 pounds per square inch gauge, depending upon the specific gravity of the oil in the line. Any reduction in static pressure, beyond that attributed to temperature differences between the oil and the pipeline environment, would indicate a leak. Preliminary studies by NTPC indicate that leaks as small as 50 to 100 barrels (0.07 to 0.14 percent respectively) of the contents of one line could be detected.

For the active or operating condition, a different type of monitoring and leak detection system would be used. Sonic flow meters would be installed at the port and at Green Point. This system would continuously monitor by computer the flow at the booster pump platform and the receiving point at the Green Point onshore storage facility. This system would have a comparative measurement accuracy of 0.5 percent of the pipeline capacity.

A second, though less accurate, leak detection system for the active condition would consist of continuous simultaneous monitoring by computer of the turbine meters on the booster pump platform and gauges on the Green Point storage tanks.

With either active condition detection system, deviation greater than the predetermined normal range would activate alarm and data printout circuits at the terminal control center. The dispatcher would shut down the operation, allow the system to become static, and monitor static pressures. If static pressure monitoring confirmed a leak, the oil in the line would be displaced with water. The line would be taken out of service while repairs were made.

The pipeline route would be patrolled twice daily by a small launch. Relatively small amounts of oil would produce a sheen on the water surface that could be detected visually. The launch would be equipped with an infrared scanning device designed to detect oil not discernible by the human eye.

The submarine pipelines would be constructed of thick-walled pipe protected by approximately 4 inches of reinforced concrete coating, and would be buried beneath the harbor bottom to lessen the possibility of damage by ship's anchor.

Onshore Storage Facility

The onshore storage facility would be constructed using approximately 140 acres of a 242-acre site approximately 6 miles east of Port Angeles near Green Point. The facility would include storage tanks, piping systems, runoff holding basins and drainage facilities, oil-water separators, oil measurement facilities, control building, and support facilities The initial pipeline pump station, main control center, maintenance facilities, and warehouse also would be located on the onshore storage site. The layout of the proposed onshore storage facility is shown in figure 1.2-3.

Initially, eleven 545,000-barrel tanks would provide 6 million barrels of storage. As throughput increases, an additional seven tanks containing 3.8 million barrels of storage would be constructed to provide storage for the projected maximum throughput of 933,000 barrels per day. If required by further growth or for operational flexibility, space would be available for construction of additional storage up to a total of 13.6 million barrels.

The proposed storage tanks would be 285 feet in diameter with a shell height of 56 feet. They would be equipped with floating roofs that would have primary and secondary sealing devices at their perimeters to minimize hydrocarbon vapor emissions.

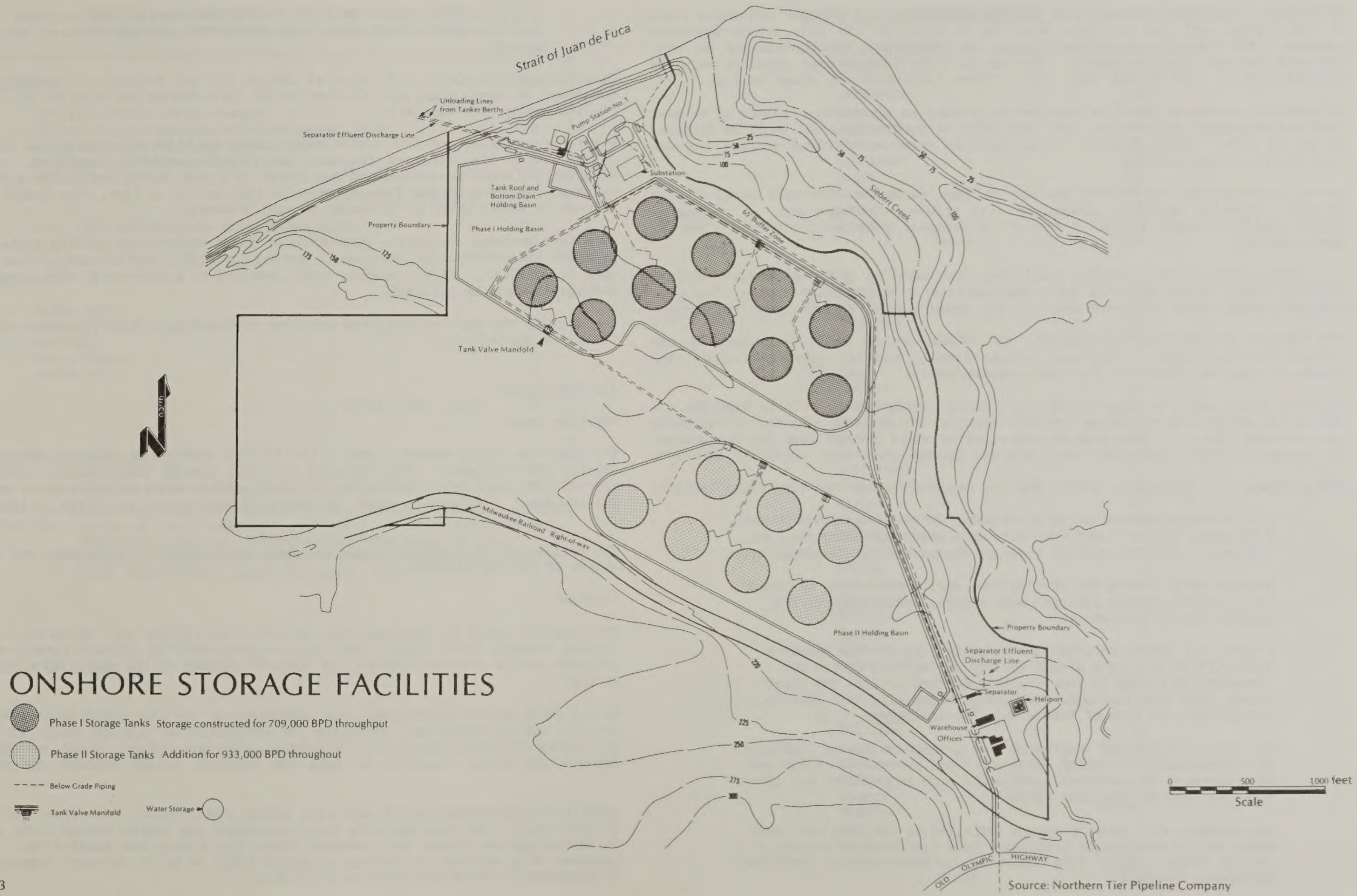
The runoff holding basins would serve two functions. If a tank, valve, or pipeline within a diked area should develop a leak, the escaped oil would be retained in the large basin and later transferred to an empty tank. The basins also would retain surface storm water runoff from within the diked areas. Then, this runoff would be processed by oil-water separators prior to discharge of the water into Seibert Creek.

Facilities for control of roof drainage, storm water runoff, and oil spillage would consist of low dikes surrounding groups of tanks and remote holding or impounding basins. Each large basin would have a capacity equal to the capacity of one tank plus a storm water allowance. The area occupied by the initial group of 11 tanks, would be enclosed on three sides by a common dike approximately 6 feet in height. The fourth side would be open to permit drainage of the tank area into the large holding basin. The area occupied by the tanks would be graded to provide slopes of at least 1 percent away from the tanks and exposed piping toward the large holding basin. The capacity allowance for storm water runoff in the holding basin would be based on the area drained and the maximum rainfall (3.3 inches) recorded in a 24-hour period in the Port Angeles area.

Permeability of onsite soils used in dike construction would be determined following completion of geotechnical studies. If onsite soils were found to be unsuitable, select offsite material would be hauled in and used for construction of an impermeable core in all dikes.

Oil-water separators would be constructed at locations indicated in figure 1.2-3. These separators would process surface water runoff from within the diked areas, as well as drainage from tank roof and bottom drains. The effluent would be discharged into Siebert Creek. Recovered oil would be collected in a compartment of the separator and transferred back to a storage tank.

The separators would use both gravity separation and coalescing filtering. During periods when no oil was present in the surface water runoff, the filtering and coalescing stage of the separator might be bypassed.



ONSHORE STORAGE FACILITIES

Phase I Storage Tanks Storage constructed for 709,000 BPD throughput
Phase II Storage Tanks Addition for 933,000 BPD throughout
Below Grade Piping
Tank Valve Manifold
Water Storage

Source: Northern Tier Pipeline Company

Figure 1.2-3

A crude oil laboratory for analyzing samples taken from ship's tanks unloading lines at the berths, and storage tanks would be provided at the main office-warehouse complex. The office building would house the controls and communications for both the port and the pipeline system. The two main facility control consoles would be located side by side in the same room. These facilities are shown in fig. 1.2-3.

If possible, earthwork would be designed to produce an approximate balance of excavation and embankment quantities. Any unsuitable or surplus material would be disposed of on the site. These disposal areas would be selected to blend surface contours with existing land contours.

During construction, short-term storage of some excavated materials would be required. Material would be stockpiled with stable sideslopes and, if necessary, runoff would be ponded to aid in removal of sediment prior to discharge to natural water courses.

Support Facilities. Support facilities and services for the onshore storage facility would include controls and communications, electric power supply, fire protection system, waste treatment and disposal, water supply, access roads, and fences.

The onshore storage facility controls and communications would be located in the office building (fig. 1.2-3) and include display panels, valve controls, tank gauges, a computer, monitors, and radio communicators.

Electric power would be supplied by the Clallam County Public Utility District. A substation would be installed on the site near the initial pump station. If electric service were lost, the pump station and pipeline would be shut down for the outage. An emergency diesel generator would provide backup power for essential services.

The proposed fire protection system for the onshore storage facility would include:

A fire system consisting of an elevated water tank, diesel-driven fire pumps with a closed loop fire main distribution system, and hydrants located to provide coverage throughout the developed area;

A water spray system for cooling tank shells consisting of piped distribution systems equipped with nozzles installed near the outside top of tank shells;

A tank seal foam protection system consisting of foam chambers installed at intervals around the top of the tank shells and connected by piping to foam trailers located outside the diked areas. The floating roofs would be provided with foam dams to concentrate the flow of foam within the seal area;

An indoor control and instrument area protection system consisting of a permanently installed halon inert gas system. Portable and hand-operated dry chemical units would also be provided for controlling interior building fires;

An automatic fire sensing system installed in the tank roof seal areas and in the control building. This system would actuate a general alarm. Manual fire reporting stations would be installed throughout the area;

A utility fire truck capable of towing foam trailers and equipped with hose reels, twin agent chemical system, and high pressure fog system.

Firefighting procedures and detailed design of the protection systems would be developed in cooperation with Clallam County Fire Protection District No. 3 and the Clallam County Fire Marshall.

Water for personnel and fire system requirements would be supplied by the local water district. If this were not feasible, onsite wells would be developed. Water for firefighting would be accumulated and stored in a tank having sufficient elevation to maintain pressure in the fire mains. In the case of a fire, fire pumps would be started to supply water to the mains at high pressure.

Temporary sanitary facilities consisting of field toilets and holding tanks would be provided for construction personnel. During operation, septic tank systems would be used if possible. If not holding tanks serviced by a commercial septic tank pumper and hauler would be utilized.

The onshore storage facility area would be enclosed by a security fence topped with strands of barbed wire.

Pipeline System

Pipeline Route

The pipeline would extend 1,491 miles through Washington, Idaho, Montana, North Dakota, and Minnesota. This includes 22 miles beneath Puget Sound. Crossings of federal and state lands and Indian reservations are shown in table 1.2-4 and in the Map Addendum. Mileage crossed, by county in each state, is listed in table 1.2-5.

The details of the proposed route are shown in the general route maps and alignment sheets of the Map Addendum.

Pipeline

The pipeline would be approximately 800 miles of 42-inch and 700 miles of 40-inch outside diameter steel pipe. Each pipe segment would be hydrostatically tested at the pipe mill at a stress equal to at least 90 percent of the specified minimum yield strength.

At all major waterway crossings, wall thickness of the pipe would be increased by 20 percent and an additional thickness of anticorrosive coating would be applied. Continuous concrete coating or individual concrete weights would be applied to provide the weight required to keep the pipeline buried beneath the streambed.

Installation procedures would vary with stream width, depth, waterflow, and terrain. In most cases, the pipe would be fully assembled and tested before being installed in the streambed trench and retested after the trench was backfilled. Pipeline crossing of a waterway in canyons or gorges might be by an overhead suspension span or supported on steel and concrete structures.

TABLE 1.2-4 ESTIMATED PIPELINE MILEAGES ACROSS FEDERAL AND STATE LANDS AND INDIAN RESERVATIONS

Federal	Mileage
National Forest System Lands	79
Bureau of Land Management administered lands	36
Department of Defense, U.S. Navy	4.5
Department of Defense, U.S. Army	2
Total federal ownership	121.5
U.S. Fish and Wildlife Service easements	26
State	
Washington	20
Idaho	2
Montana	32
North Dakota	6
Minnesota	0
Total state lands	60
Indian Reservations	
Coeur d'Alene reservation, Idaho	26

Sources: Bureau of Land Management, surface minerals management maps; USDA Forest Service, Environmental Assessment on the Northern Tier Pipeline Proposal 1978; personal communication, North Dakota State Lands Department 1979

TABLE 1.2-5 PIPELINE MILEAGE BY STATE AND COUNTY

State and County	Pipeline Mileage
Washington	
Clallam	17
Jefferson	10
Island	28
Snohomish	48
King	42
Kittitas	79
Grant	50
Lincoln	39
Adams	16
Spokane	38
Total	367
Idaho	
Benewah	21
Kootenai	22
Shoshone	33
Total	76
Montana	
Sanders	63
Missoula	73
Granite	14
Powell	43
Lewis & Clark	32
Jefferson	1
Broadwater	44
Meagher	43
Wheatland	43
Golden Valley	19
Musselshell	17
Fergus	2
Petroleum	37
Garfield	84
McCone	55
Dawson	2
Richard	56
Roosevelt	3
Total	631
North Dakota	
Williams	61
Mountrail	42
Ward	42
McHenry	37
Pierce	18
Benson	31
Ramsey	41
Nelson	26
Grand Forks	44
Total	342

TABLE 1.2-5 (Continued)

State and County	Pipeline Mileage
Minnesota	
Polk	54
Red Lake	13
Clearwater	8
Total	73
Total pipeline	1,491

Source: NTPC 1978 (rev. 1979)

Major stream crossing construction would be done during a period designated by agencies responsible for protection of fish and wildlife. Irrigation canal and ditch crossings would be constructed to comply with requirements of the irrigation district.

Locations and sizes of other known crude oil, refined product, and natural gas pipelines crossing the system are shown in the Map Addendum. NTPC would develop procedures to protect these pipelines from damage during construction of the pipeline. In addition, lines would be electrically insulated from each other, and above ground cathodic protection test stations would be installed to monitor the system for stray current between the lines.

Joint use of right-of-way by pipelines and high-voltage alternating current transmission lines would minimize land required for these corridors. However, such joint use would create interferences and electrical hazards that would need to be considered in design, construction, and operation of pipeline facilities. The magnitude of the induced voltage that could occur in the pipeline would be considered in the system design. Table 1.2-6 shows the miles that the pipeline route parallels existing utility corridors.

During construction, safety measures would be taken to prevent induction of dangerous voltages on the pipe before it was lowered into the trench.

TABLE 1.2-6 PIPELINE ROUTE--USE OF UTILITY AND RAILROAD CORRIDORS

	Pipeline Route Adjacent to Existing			
State	Powerline Right-of-Way (miles)	Pipeline Right-of-Way (miles)	Railroad Right-of-Way (miles)	Total (miles)
Washington	102.0	24.4	14.5	140.9
Idaho	13.8	10.3	0	24.1
Montana	19.1	70.0	4.0	93.1
North Dakota	21.0	120.7	43.8	185.5
Minnesota	0	60.3	0	60.3
Total	155.9	285.7	62.3	503.9

Source: NTPC June 1978 (rev. 1979)

After construction, potentially hazardous voltages would still be a problem. Measures such as a system of bonds and insulated flanges coordinated with the design of the cathodic protection system would be used to lessen this hazard.

To prevent corrosion from pipe-soil contact, an external coating would be applied to pipe at the pipe mill or at stockpile sites along the route. Weld joints and underground main line valves would be field coated. Additional coating would be field applied on river crossing pipe. In rocky areas, rockshield tape would be applied before installation.

On completion of construction, a cathodic protection system would be designed based on actual pipe-to-soil measurements. The system to be used would consist of rectifiers which convert alternating current to direct current, connected to ground beds (anodes) along the pipeline route. The ground bed location and power output would facilitate a continuous current flowing into the pipeline from the soil.

Traps for launching and receiving pipeline scrapers would be provided at selected points on the system. Depending on operating conditions the scrapers would be sent through the line at various intervals to remove solids on the interior pipe wall. Approximately eight launching and eight receiving traps would be required.

Main Line Valves

Main line valves would be of two types: (1) block valves which could be operated remotely or locally, and (2) check valves which would permit flow in only one direction. Check valves would be installed at the base of uphill sections of the pipeline and would prevent backflow during shutdown or rupture.

All main line block valves would be remotely controlled from the pipeline system control center at the onshore storage facility. Main line valves would be installed where required by Department of Transportation regulations. Those located in open areas would be landscaped.

Main line valve locations are shown in the Map Addendum.

Main Line Stations

Twenty-one main line stations would be installed along the pipeline system. For the initial system capacity of 709,000 barrels per day, 17 pump stations and 1 pressure reducing station would be constructed. Of the remaining three stations required for ultimate capacity, station 16 would include a surge relief tank installation for initial operating purposes. The remaining sites, stations 19 and 21, initially would be established as future pump station locations with fencing and station block valves. The locations of mainline stations, each of which would occupy about 5 to 6 acres, are shown in table 1.2-7.

Each pump station would include the following equipment:

Electrical pump units acoustically designed to maintain noise levels at 63.6-69.6 decibels (dBA)(A-scale) depending on the number of units operating;

Surge relief tank, if needed to correct for terrain profile or system operating factors;

Launchers and receivers for pipeline cleaning equipment;

A pipeline leak detection and monitoring system;

TABLE 1.2-7 MAIN LINE STATIONS
LOCATIONS, HORSEPOWER AND ELECTRICAL POWER REQUIREMENTS

			Horsepower		Electrical Demand Initial (709,000 bpd)		Electrical Demand Ultimate (933,000 bpd)	
State and County	Station Name (number)	Miles from Onshore Storage	Initial (709,000 bpd)	Ultimate (933,000 bpd)	Demand MW	Annual Energy KWH (million)	Demand MW	Annual Energy KWH (million)
Washington								
Clallam	Port Angeles (1)	0	8,453	17,063	6.6	55.2	13.3	110.4
Snohomish	Arlington (2)	66	9,085	14,733	7.1	58.8	11.5	96.0
King	Carnation (3)	115	10,071	15,883	7.8	64.8	12.3	102.0
King	Bandera (4)	137	9,326	13,059	7.2	60.0	10.0	84.0
Kittitas	Ellensburg (5)	194	13,603	22,953	10.6	88.8	17.8	147.6
Grant	Quincy (6)a/	227	400	400	0.3	2.4	0.3	2.4
Adams	Odessa (7)	293	4,632	14,451	3.6	30.0	11.2	93.6
Spokane	Plaza (8)	346	9,751	15,808	7.6	63.6	12.3	102.0
Idaho								
Kootenai	Cataldo (9)	398	6,194	9,567	4.8	39.6	7.4	61.2
Shoshone	Enaville (10)	416	9,602	15,498	7.5	62.4	12.0	99.6
Montana								
Sanders	Paradise (11)	494	7,878	20,618	6.1	50.4	16.0	133.2
Missoula	Potomac (12)	573	17,853	26,915	13.9	115.2	20.9	174.0
Powell	Elliston (13)	634	4,092	8,966	3.2	26.4	7.0	58.8
Broadwater	Townsend (14)	699	7,929	20,142	6.2	51.6	15.7	130.8
Wheatland	Harlowton (15)	798	6,471	12,363	7.3	46.8	10.5	81.6
Garfield	Jordan (16)	941	0	17,334	-	-	13.5	112.8
Richland	Richey (17)	1029	6,315	15,061	5.5	43.2	12.6	99.6
North Dakota								
Williams	Tioga (18)	1132	9,450	12,268	7.3	61.2	9.5	79.2
McHenry	Towner (19)	1243	0	12,701	-	-	9.9	82.8
Ramsey	Devils Lake (20)	1324	10,945	13,703	8.5	70.8	10.6	88.8
Minnesota								
Polk	Crookston (21)	1434	0	11,851	-	-	9.2	78.0
			Total - Pipeline		121.1	991.2	243.6	2,018.4

Source: NTPC (rev. March 1979)
a/ Pressure reducing station.

Strainers, drain system, piping and control valves;

High voltage supply, tranformer, switchgear and emergency generator; and

Control building, communications tower, heliport, access road and fencing.

The initial main line pump station located at the onshore storage facility site, would include all the above equipment, plus booster pump units, and a metering facility. See figure 1.2-4.

The pump units would be acoustically designed. The combined noise level of pumping units would range from 63.6 dBA to 69.6 dBA measured at 104 feet (NTPC 1978).

Size of the individual pump units would vary to meet horsepower requirements shown in table 1.2-7 for the initial system capacity and for the ultimate system capacity.

The station piping would direct oil through selected pumping units. Motor-operated valves would provide isolation for all major equipment. Most valves would be keyed to the operation of adjacent equipment, and the valves would open or close as a part of a predetermined automatic sequence when equipment was put into operation or shut down. Lock-out features on the controls for each valve would provide security to prevent accidental opening during maintenance.

As part of the leak detection system, suction and discharge pressure at each pump station would be telemetered to the main control center and monitored for deviations and rates of change. Deviations as small as 0.5 percent of the pipeline throughput would be detected and would provide a leak alarm within 2 minutes of the incident. NTPC estimates that it would take less than 10 minutes to reduce the system from full operating condition to complete shutdown in the event that a line breaks or leaks.

Electric power for the pump stations would be provided by the utility companies serving the area. Overhead electric service lines would vary from 69 to 230 kV, depending on station horsepower requirements and service voltage available.

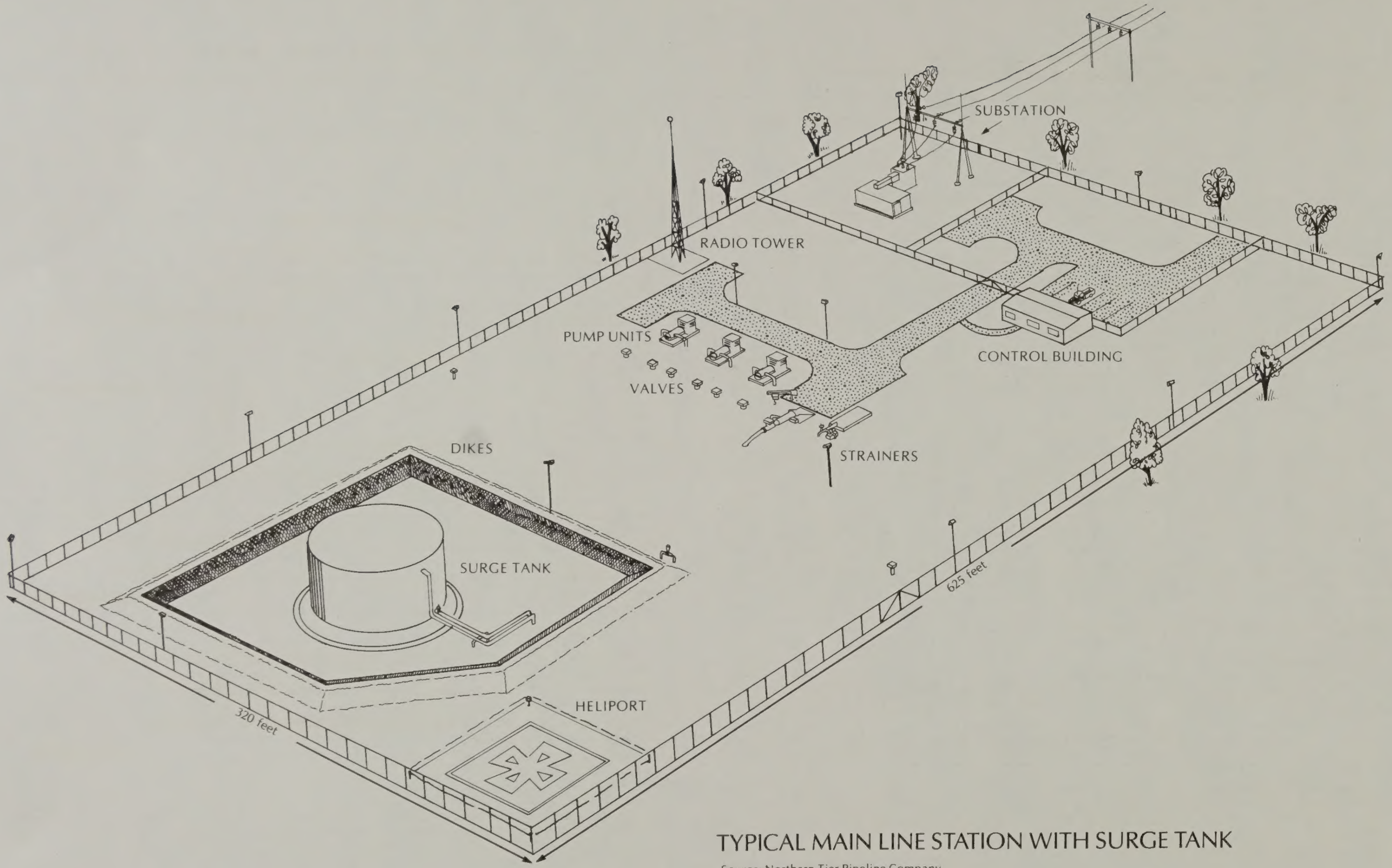
Table 1.2-7 shows the electrical power requirements for the pipeline system.

The function of the pressure reducing station is to protect downstream pipe from overpressure due to changes in terrain. Major equipment and support facilities at the pressure reducing station include the pressure reducing valves, surge relief tank (if required), piping, control building, power supply and transformers, communication tower, heliport, roadways, lighting, emergency generator, and fencing.

Delivery Facilities

Four delivery facilities would be constructed along the pipeline route as crude oil transfer points to existing pipelines as shown in table 1.2-8.

Each delivery facility would receive consignments of oil from the pipeline and deliver them to connecting pipeline systems. This process would be controlled from the main control center at the onshore storage facility. At each delivery facility



TYPICAL MAIN LINE STATION WITH SURGE TANK

Source: Northern Tier Pipeline Company
Artist's Conception
Not Drawn to Scale

Figure 1.2-4

there would be back-pressure and flow control on the pipeline; a relief system to prevent overpressuring the last segment of the pipeline; a metering system to account for the quantities of oil delivered to connecting pipeline carriers; quality measurement to assure the delivery of the proper crude oil segregation; and control of the manifolding to direct the oil stream to the designated carrier. Support facilities would include control building, control system, power supply, communication tower, heliport, roadways, lighting, and fencing.

TABLE 1.2-8 INTERMEDIATE AND TERMINAL DELIVERY FACILITIES

	Glacier Pipeline	Western Crude Pipeline	Amoco Pipeline	Minnesota and Lakehead Pipeline
Location	Pipeline Mile 798 Wheatland Co., Montana, 10 miles NE of Harlowton	Pipeline Mile 1,029 Richland Co., Montana, 20 miles NE of Richey	Pipeline Mile 1,131 Williams Co., N Dakota, 33 miles west of Williston.	Pipeline Mile 1,491, Clearwater Co., Minnesota
Pump station planned	Yes	Yes	Yes	No
Initial and ultimate capacity	95,000 - 115,000 bpd	50,000 - 60,000 bpd	14,000 - 18,000 bpd	550,000 - 740,000 bpd
Storage volume	647,000 barrels	394,000 barrels	123,000 barrels	existing, plus 1,000,000 barrels

Source: NTPC 1978 (rev. April 1979)

Construction, Operation, and Abandonment Phases

Construction Phase

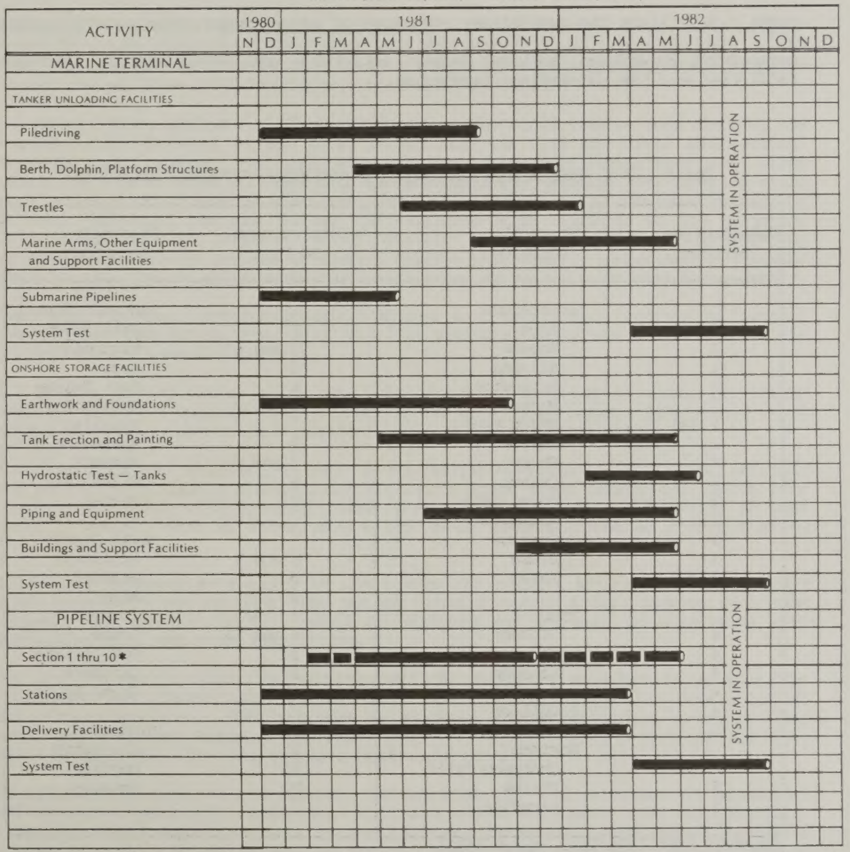
Construction Schedules. Construction of the proposed pipeline system would be by specialized construction crews working simultaneously on various facilities.

Figure 1.2-5 shows the construction schedule for the initial phase of the proposed project, illustrating the effort to be undertaken for the port and pipeline system.

Construction management and inspection would be by NTPC personnel responsible for coordinating the contractors and assuring work was in accordance with construction specifications. Testing and checkout of the completed system would also be by these personnel. Additional inspectors would be assigned where special construction, such as river crossings, was involved.

Major construction materials would be purchased in advance to minimize delay before installation. Construction contractors would arrange for temporary stockpiling or

NORTHERN TIER PIPELINE SYSTEM
Preliminary Construction Schedule
Initial System Capacity — 709,000 Barrels per day



*Construction of certain sections could extend into the winter months where weather would permit or where timing of construction of river crossings requires it as indicated by the broken line.

Figure 1.2-5

Source: Northern Tier Pipeline Company

warehousing of these items (table 1.2-9). See Map Addendum for location of specified construction sections. These locations would usually be rented or leased; however, station sites and possibly contractor-owned facilities would be used whenever possible. About 12 acres would be required at each location.

Table 1.2-10 lists the preliminary estimates of major construction material costs.

Restoration procedures include cleanup activities and revegetation. Permanent facilities would be painted and landscaped.

TABLE 1.2-9 PRELIMINARY CONSTRUCTION MATERIALS STOCKPILE LOCATIONS

Construction Section	Stockpile Location	Construction Section	Stockpile Location
	Washington		Montana (Cont.)
1	Agnew	5	Frenchtown
1	Sequim	5 and 6	Missoula
1	Silvana	6	Avon
1	Arlington	6	East Helena
1	Monroe	6 and 7	Townsend
1 and 2	North Bend	7	Ringling
2	Easton	7	Harlowton
2	Thorp	7 and 8	Winnett
3	Quincy	8	Miles City
3	Moses Lake	8	Richey
3	Marcellus		
3	Sprague		North Dakota
3	Plaza	8 and 9	Williston
3 and 4	Latah	9	Stanley
		9	Minot
	Idaho	9	Towner
4	Plummer	9 and 10	Leeds
4	St. Joe	10	Devils Lake
4	Cataldo	10	Larimore
4	Enaville	10	Grand Forks
4	Wallace		
			Minnesota
	Montana	10	Crookston
4 and 5	Thompson Falls	10	Dugdale
5	Plains	10	Fosston
5	Paradise		

Source: NTPC 1978 (rev. March 1979)

TABLE 1.2-10 ESTIMATED CONSTRUCTION MATERIAL REQUIREMENTS 1/
(Thousands of dollars)

		Washington		Idaho		Montana		North Dakota		Minnesota		Total	
Material	Measure	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Steel:													
Tanks	tons	35,077	$14,430	270	$108	4,335	$1,734	705	$282	135	$54	40,522	$16,608
Reinforcing	tons	3,107	1,152	6	2	63	23	15	6	9	4	3,200	1,187
Structural	tons	11,790	5,816	20	8	73	29	32	13	13	6	11,928	5,872
Conduit	tons	290	508	14	24	90	158	39	68	14	24	447	782
Copper	tons	124	432	12	42	44	154	19	67	7	24	206	719
Concrete	cu.yd.	73,266	2,243	548	17	2,940	97	691	20	398	13	77,843	2,390
Lumber	M bd.ft.	413	157	11	5	41	17	19	8	7	4	491	191
Select Fill	cu.yd.	56,000	336	6,000	36	27,000	162	12,000	72	8,000	48	109,000	654
Gravel	cu.yd.	6,540	44	1,504	10	5,264	35	2,256	15	752	5	16,316	109
Asphalt	tons	3,344	52	500	8	1,750	28	750	12	250	4	6,594	104
Fence	-	-	160	-	20	-	70	-	30	-	10	-	290

Source: NTPC 1979

1/ Pipe steel requirements would amount to 16,819 tons for the port and onshore storage facilities and 690,336 tons for the pipeline system.

Port and Onshore Storage Facilities. The construction schedule for port and onshore storage facilities is in figure 1.2-5. Construction personnel required for the port and onshore storage construction are shown in table 1.2-11.

TABLE 1.2-11 PORT AND ONSHORE STORAGE FACILITY
NUMBER OF CONSTRUCTION PERSONNEL REQUIRED

Classification	Port Facility	Submarine Pipelines	Onshore Storage Facility
Supervisory and field office	11	32	24
Welders	24	21	54
Welder-helpers	6	20	12
Operators	5	41	10
Teamsters	19	21	42
Semiskilled	25	18	58
Unskilled	0	90	0
Total	90	243	200

Source: NTPC 1978

The submarine pipelines would be installed by either the lay barge or bottom-pull method.

The lay barge method consists of welding joints or double joints of pipe into a continuous pipeline. The barge winches itself forward on its anchor lines as the welded pipe leaves the barge supported by the stringer. During laying in deep water, the pipe would be maintained under tension by means of a constant tension winch. The tension, stringer length, and stringer articulation would be adjusted for water depth and pipe size.

The bottom-pull method consists of making relatively long strings of pipe in a shore fabrication yard adjacent to the launching point. Strings of pipe are successively placed on a roller launchway and pulled into the water by an anchored winch barge. The pulling must stop after each string-length pull for several hours while the succeeding string is welded onto the line.

Both methods require the use of specialized marine equipment. The bottom-pull method would require use of a portion of the U.S. Coast Guard station as a fabrication yard and pipe launch ramp. Burial beneath the harbor bottom would be required in either case and trenching methods would be similar. Trenching would be by hydraulic and air jetting after laying or by clamshell or other type dredge before laying.

All welds of marine piping would be inspected by x-ray or gamma ray prior to application of the corrosion preventive and other coatings. Additionally, all elements of the marine facilities piping systems, including the submarine lines, booster pump platform piping, berth platform piping, and platform interconnecting piping would be hydrostatically tested.

Temporary sheet pile bulkheads would be constructed on each side of the pipeway through the Green Point surf zone in order to preserve the pipeline trench in the shallow water zone during construction. The trench through this zone would be dug by a clamshell or similar dredge regardless of the method used for trenching the rest of the line. The need for mechanical backfilling of the trench over the completed line would be determined after geotechnical and bottom current studies were completed.

The submarine pipelines would terminate in vertical risers installed in a narrow, shallow slot in the sea bluff at Green Point. The slot would be approximately 16 feet wide, 15 feet deep, and would be backfilled with grouted rock or bagged concrete to approximately the original profile of the bluff.

The design, material fabrication, and erection of the storage tanks would be performed by a tank contracting specialist at a fabrication plant before delivery to the site. Deliveries would be by rail or by a combination of barge and truck transportation, and would be spread throughout the building schedule.

All exposed steel surfaces of finished storage tanks would receive shop cleaning and priming before delivery to the site, to minimize the need for field sandblasting. The tanks would receive final protective coatings of paint following erection. Paint colors would be selected to blend with the surroundings. Storage tank painting would begin about 9 or 10 months after the start of construction at the onshore storage facility and would continue during the remaining 8 or 9 months of the projected 18-month construction period. It is possible that the painting period might be extended 1 or 2 months because of adverse weather conditions. Approximately 2 months would be required to paint each tank, with three tanks being painted concurrently.

Tank erection would require about 13 months with concurrent erection of several tanks. Upon completion, the tanks would be hydrostatically tested by the complete filling of each tank with water.

All onshore piping system welds would be inspected by x-ray or gamma ray before application of the anticorrosive coating to the weld joint areas. Additionally, all elements of the completed piping systems would be hydrostatically tested.

Disturbed areas not occupied by constructed facilities would be fertilized, mulched, and seeded to produce a ground cover to retard storm water runoff and reduce soil erosion. Original site drainage patterns would be preserved and restored if possible. Devices such as ditch checks and ditch linings would be constructed to control erosion.

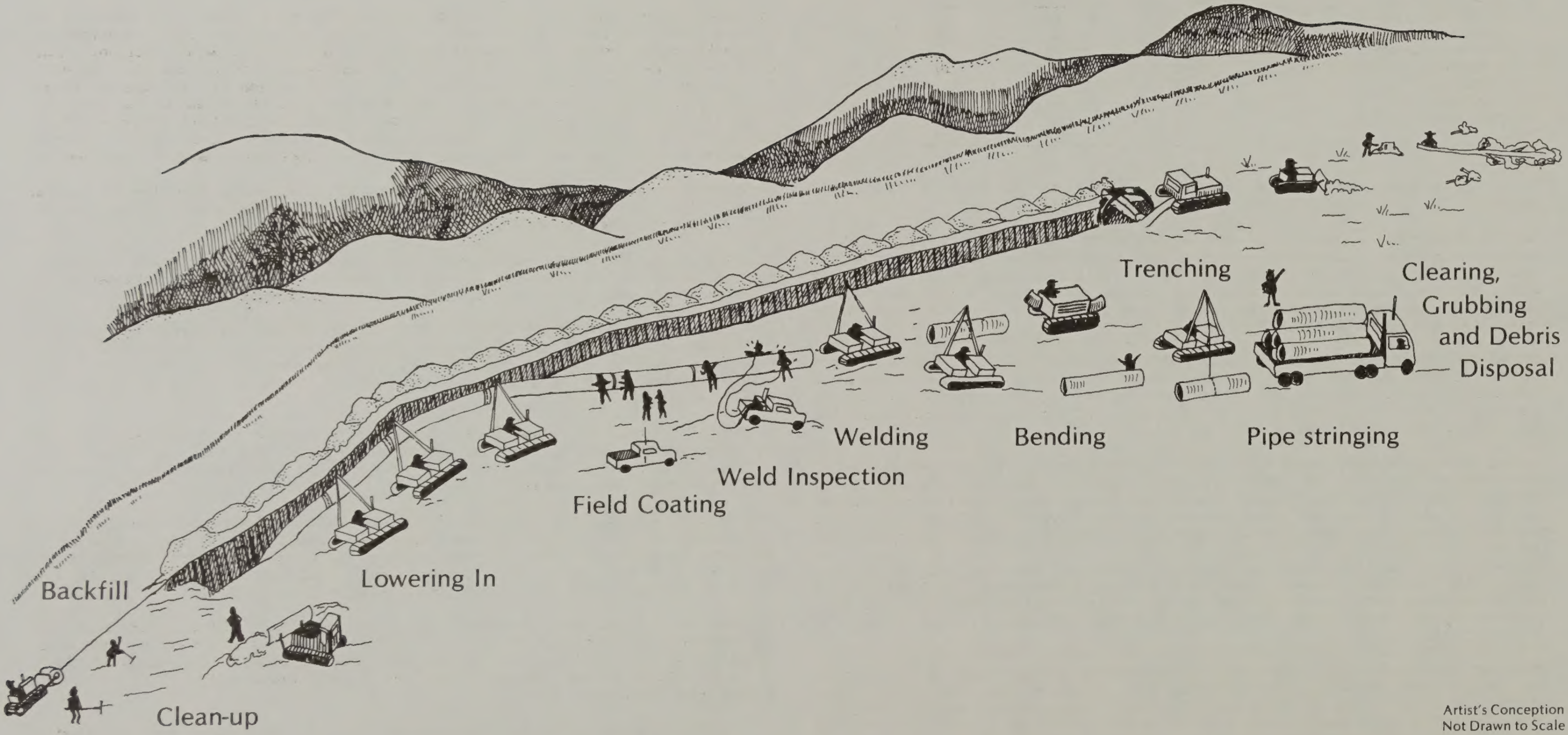
A landfill disposal site would be constructed to receive sediments from the oil-water separators and possibly tank bottom sediment should a leak develop in a tank bottom. The on-site landfill would be designed and operated in compliance with applicable local and state regulations.

The grounds surrounding the control, office, and warehouse buildings would be landscaped and planted with shrubs and trees compatible with the vegetation of adjoining properties. NTPC proposes to maintain a 100-foot buffer along the sea bluff and a 65-foot buffer along Siebert Creek. Buffers of 130 feet and 200 feet would be maintained from the northern bald eagle perch site.

In addition to contractor personnel, approximately 15 NTPC construction management and inspection personnel would assure that work was in accordance with the specifications and would coordinate work of the various contractors. NTPC would provide a trained traffic control person at the Old Olympic Highway, US 101, intersection during peak commuting hours.

Pipeline System. The pipeline system would be constructed over a period of approximately 8 to 12 months depending on permit timing. The major portion of the pipeline work would be accomplished from April through November. Work would proceed

TYPICAL PIPELINE CONSTRUCTION SPREAD



Artist's Conception
Not Drawn to Scale

Figure 1.2-6

Source: Northern Tier Pipeline Company

concurrently on each of 10 construction spreads. The length of each spread would depend on type of terrain, restricted right-of-way, and number of river crossings. See table 1.2-12 and the Map Addendum.

TABLE 1.2-12
CONSTRUCTION PERSONNEL REQUIRED BY SPREAD 1/

Classification	Spread 1 and 2	Spread 3,4,5,6 and 7	Spread 8,9 and 1
Supervisory and field office	37	57	36
Welders	44	38	48
Welder-helpers	45	37	45
Operators	106	75	84
Teamsters	51	37	47
Semiskilled	29	32	59
Unskilled	168	164	81
Total	480	440	400

Source: NTPC 1978
1/ Does not include construction of across Puget Sound submarine pipeline.

Right-of-way agreements or easements would be negotiated with private property owners. NTPC would make one payment to property owners for the easement and damages that might occur during construction. Other payments would be made to the landowner during the life of the project for damages that might occur during maintenance of the pipeline. Easements negotiated with private landowners would be for an indefinite term.

The right-of-way agreements obtained from public agencies and private landowners would convey to the company the right to survey the route, clear and grade the right-of-way for construction, install the pipeline, and provide access for operation and maintenance. Generally, the width of permanent right-of-way would be 75 feet; however, an additional 15 feet would be required temporarily for adequate working space.

Each pipeline construction spread would be made up of several units and would generally proceed as illustrated in figure 1.2-6.

Pipe-stringing trucks would transport the pipe in 40- to 80-foot lengths from storage yards to the right-of-way. Along the right-of-way, sideboom tractors would lay the pipe beside the trench line for lineup and welding.

Pipe stringing would usually precede trenching. When required, blasting would precede stringing to avoid damage to the pipe. When possible, a conventional trenching machine would be used, but backhoes, power shovels, drag lines, hand tools, rippers, or combinations would be utilized as required. Double trenching would be used to segregate and replace topsoil as illustrated in figure 1.2-7. The soil then would be compacted to minimize slumping. A minimum three feet of cover over the pipe would be maintained.

Typical Right of Way Construction
(Double Ditching)

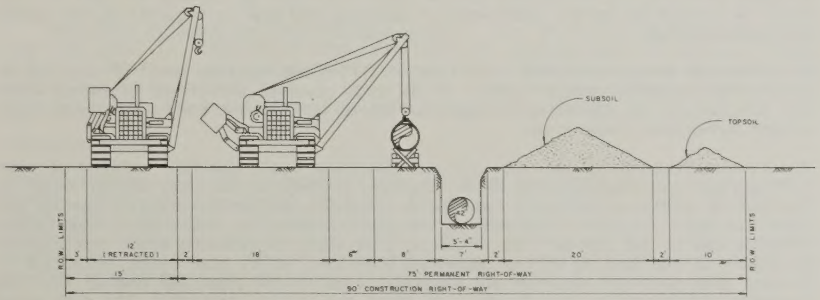


Figure 1.2-7

Source: Northern Tier Pipeline Company

All field welds would be non-destructively tested by the radiographic method using the services of an independent contractor.

Figure 1.2-8 depicts typical backfill requirements. Motor graders, angle dozers, crawler-mounted side-pull backfillers, and auger backfillers would move dirt from the spoil bank to the ditch. The backfilled earth would be compacted to minimize later settling. In certain areas where damage to the coating might occur, additional protection would be provided by padding the trench with select backfill material. In rocky areas, the pipe would be further protected with rock-shielding materials.

Soil excavated in the trenching operation would be returned to the trench as backfill. Excess spoil would be crowned up over the trench so that normal settlement would not create a depression in the trench line. Any excavated material deemed unsuitable for use as backfill or surplus to need would be disposed of in a manner acceptable to the property owner.

Pipeline crossings of highways, roads, and railroads would be accomplished by methods determined by authorities having jurisdiction. Major highway and railroad crossings are normally bored and cased with a steel pipe large enough to allow the installation of the main or carrier pipe through the casing. Where the roads are unimproved or boring is impractical, the crossing may be constructed by open cutting.

Along the route, a number of waterways would be encountered, varying in width, depth, water flow, and terrain. Submerged crossings would be constructed so the pipe would be below the scour level of the streambed. The ends of the crossing pipe would extend into the banks of the waterway beyond the point of high water scour. Figure 1.2-9 illustrates a typical river crossing.

Design of crossings would be in accordance with the requirements of permitting agencies. The method of excavation and construction of the crossing would depend on the characteristics of the waterway.

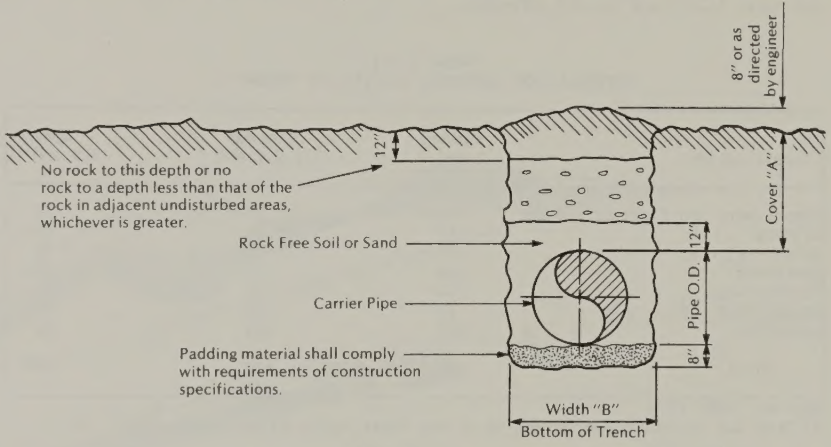
Drainage ditches and irrigation canals that could not be crossed by open cutting could be crossed by boring underneath or spanning overhead as required by the agency with jurisdiction.

If the stream bottom contained solid rock, drilling and blasting would be required to secure the necessary trench depth. As on land, blasting for stream crossings would use multiholed, low intensity charges sufficient to fracture the rock without scattering debris over large areas.

The construction procedure for stream crossings would include welding of pipe sections on land, examining the welds, applying protective coatings, adding weight in the form of concrete coating to the pipe as required, and hydrostatically testing the pipe sections. All work to be done on the pipeline would be completed on land before installation in the stream. The crossing pipe would be retested after installation as a part of the testing of the completed pipeline. Empty pipe would be carried or floated into position with the aid of floats tied to the pipe and lowered into the trench by disconnecting the floats. On short and shallow crossings, the pipe would be placed directly in the trench with sideboom tractors.

After the pipe was in place, the trench would be backfilled using excavated or other material. The trench line and banks of the stream would be restored to approximately

MINIMUM PIPELINE TRENCH AND BACKFILL REQUIREMENTS


8" or as directed by engineer
12"
No rock to this depth or no rock to a depth less than that of the rock in adjacent undisturbed areas, whichever is greater.
Cover "A"
12"
Rock Free Soil or Sand
Carrier Pipe
Pipe O.D.
Padding material shall comply with requirements of construction specifications.
8"
Width "B"
Bottom of Trench

Not Drawn to Scale

Nominal Pipe Size (Inches)	Required Dimensions (Inches) For Pipe Installation (1)											
	Residential, Commercial & Industrial Areas			Crossings of Water Courses			Drainage Ditches At Railroads & Public Roads			All Other Areas		
	Cover "A"		Width "B"	Cover "A"		Width "B"	Cover "A"		Width "B"	Cover "A" (2)		Width "B"
	Norm Excav	Rock		Norm Excav	Rock		Norm Excav	Rock		Norm Excav	Rock	
40	36	30	62	48	18	76	36	36	62	36	18	62
42	36	30	64	48	18	78	36	36	64	36	18	64

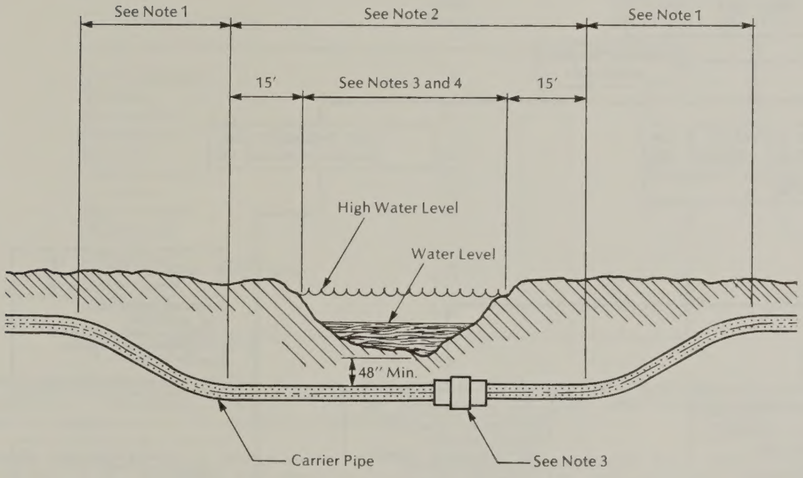
NOTES:

1. These are minimum specifications.
2. Cover may be greater in areas where deep cultivation occurs or is likely to occur. Additional cover may be required in rock areas. Refer to the alignment sheets and/or construction line list for such additional requirements.

Source: Northern Tier Pipeline Company

Figure 1.2-8

TYPICAL STREAM CROSSING REQUIREMENTS



NOTES:

1. This distance will vary depending upon terrain.
2. Pipe shall be level under stream channel to the depth shown above except in rock formations where top of pipe may be laid to a minimum of 18″ below stream bed.
3. Contractor shall furnish and install concrete weights per specifications and as shown on applicable drawings. Alternatively, concrete coated pipe may be furnished to contractor.
4. For high water widths over 100 ft., continuous concrete coated pipe will be furnished by company and installed by contractor.

Source: Northern Tier Pipeline Company

Figure 1.2-9

their former condition. Riprap or other materials would be placed on the banks for stabilization and to prevent erosion. Major stream crossings would be scheduled for installation during the normal period of low streamflow or during a period designated by the appropriate agency.

When constructing the pipeline through marshy areas, special backfill material such as bentonite clay, which forms an impermeable barrier to water, could be utilized if drainage potential existed.

In addition to standard mill testing of all pipe and fittings, hydrostatic testing would be performed after construction and before the line was placed in operation. Testing would involve filling the line with a suitable liquid, usually fresh water, to a predetermined internal pressure. This pressure would be equivalent to a minimum of 1.25 times the internal design pressure of the pipe. The test pressure would be maintained for a period of 24 hours.

Water for testing would be obtained from local streams or rivers if available. The water would be transferred from test section to section unless local restrictions required returning the water to the source. Water used for testing would be fresh, free of precipitates, sewage and oil, with a pH factor of 6.7 to 7.2. After testing of the line, the water would be returned to a watercourse, as required by the Environmental Protection Agency.

Markers showing exact locations of the pipeline would be installed at road, railroad, and fence crossings. Markers suitable for observation from the air would also be installed for use by the aerial line flyer.

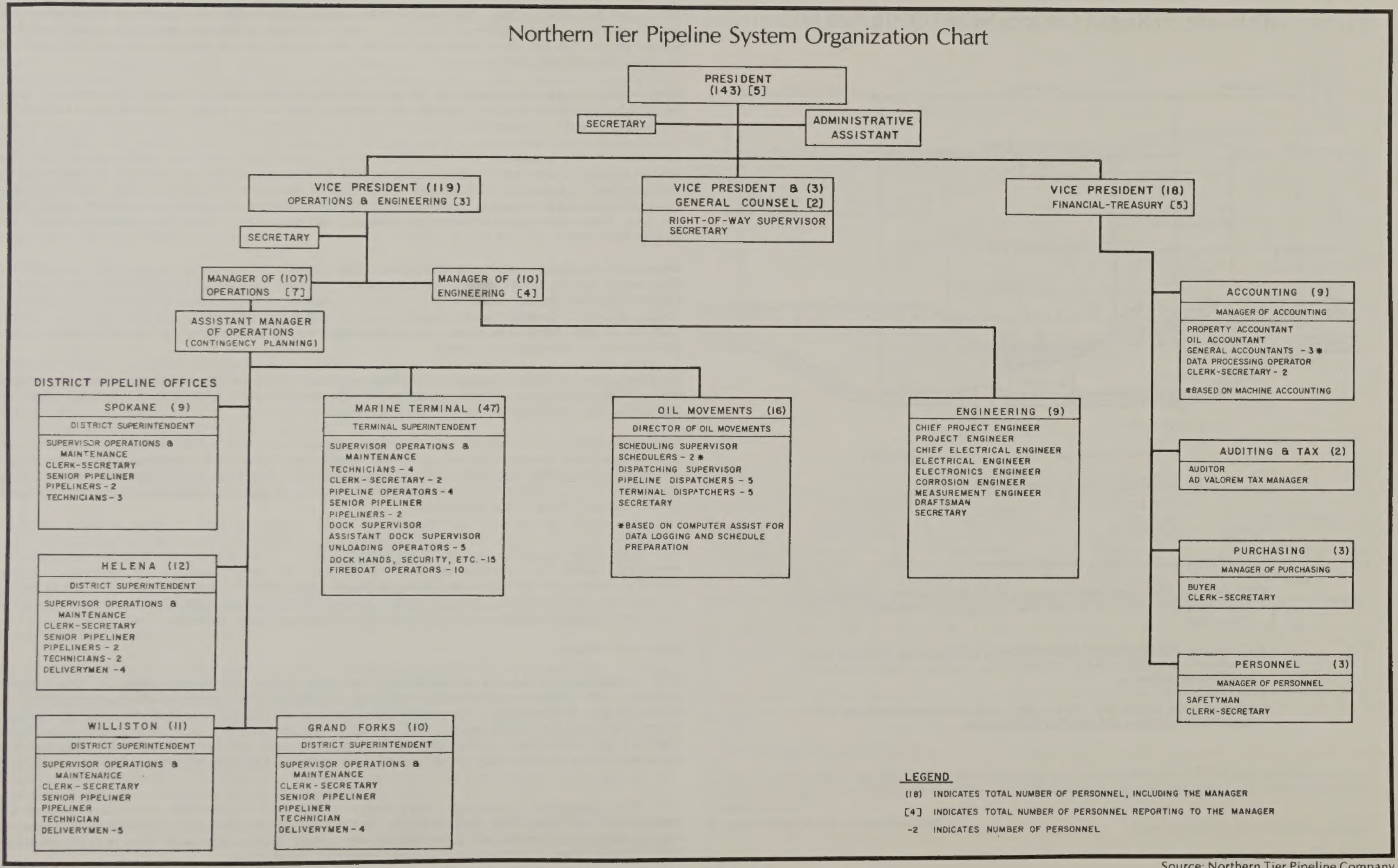
Terracing and installation of drainage structures might be needed to control or divert surface waterflow and prevent washouts along the trench line. Seeding, mulching, and other methods of soil stabilization would be specified in construction specifications. Revegetation plans for crossing of public lands would be as approved by the agency having jurisdiction.

Main Line Stations and Delivery Facilities. As shown in figure 1.2-5, the stations would be constructed over a period of approximately 16 months. Table 1.2-13 lists the number of construction personnel required for a typical pump station and delivery facility. It is estimated that a maximum of 42 workers would be required at peak construction periods for a typical pump station.

Operation Phase

NTPC employees would be responsible for operation and maintenance of the entire system. The operations center would be located at the onshore storage facility at Green Point, Washington. Personnel stationed at permanent locations would be responsible for routine maintenance and repair. Major repairs and maintenance would be handled by contract. The proposed organizational structure of the company and manpower requirements for operation of the system is shown in figure 1.2-10.

Port and Onshore Storage Facilities. The port operation would be controlled and monitored from the main control center at Green Point. Terminal dispatchers, reporting to the terminal superintendent, would be in charge of the port, including the booster pump platform and onshore storage facilities.



Northern Tier Pipeline System Organization Chart

Source: Northern Tier Pipeline Company

Figure 1.2-10

TABLE 1.2-13 PUMP STATION AND DELIVERY FACILITY CONSTRUCTION PERSONNEL REQUIRED

Classification	Typical Pump Station	Typical Delivery Facility
Superintendent	1	1
Foremen	11	11
Operators	11	9
Teamsters	3	3
Skilled	32	24
Semiskilled	26	25
Laborers	18	17
Apprentices	14	10
Engineers	2	2
Surveyors	1	1
Materialsman and clerks	3	2
Total	122	105

Source: NTPC 1978

Operation of the port at Ediz Hook would be controlled by the dock supervisor and an assistant. Unloading operators with the assistance of dock hands would perform routine operations on the berthing platforms.

Tanker deliveries would be scheduled by the shippers in accordance with long-term programs to be submitted to NTPC's operations manager. An inbound tanker would advise the terminal of its estimated time of arrival 24 to 36 hours from port. Tankers would be required to use bunker fuel containing no more than 0.45 percent sulfur while in port.

Berthing of the ship would be accomplished by tugs, line-handling launches, and dock personnel. After berthing, retractable oil booms would be deployed to encircle the ship. After the oil was unloaded, the unloading arms would be cleared of oil and disconnected, the ship's tanks would be gauged and checked, and the oil would be sampled. The ship would be supplied with drinking water and fuel oil before its departure. The ship would take on ballast water aproximating 20 percent of its deadweight tonnage prior to leaving the berth.

Pipeline System. The main line stations and delivery facilities would be designed for unattended operation and would be remotely controlled by the pipeline dispatcher with the aid of a computer-assisted supervisory control and acquisition system.

The system, as proposed, would be redundant and would be estimated to have a reliability of 99.9 percent. Scan of data at all remote sites would occur every 10 seconds. Through this system, the port and pipeline dispatchers would be aware of the status of all equipment. Failures would be indicated by alarms. The dispatchers could then take action to correct the condition. If the problem could not be handled remotely from the main control center, the dispatcher would call field personnel to correct the condition.

District pipeline offices at Spokane, Washington; Billings, Montana; and Minot, North Dakota. would be responsible for maintaining and inspecting the pipeline and station facilities. Major repair or maintenance for the pipeline and pump stations would be handled by contract.

The surface conditions on and near the pipeline right-of-way would be inspected by aircraft every 2 weeks. The line flyer would report to the nearest pipeline office oil leaks, construction activities near the pipeline which could result in damage to the pipeline, and potential threats to the pipeline such as erosion or flooding.

Underwater crossings of navigable waterways would be inspected to determine their condition at intervals not exceeding 5 years as required by Department of Transportation regulations.

The communications system would link the port, district offices, and pipeline system with the main control center at the onshore storage facility.

Abandonment Phase

Future situations could make the operation of the proposed system unfeasible. Conditions such as insufficient crude oil or other economic situations could terminate the operation of the entire system. Terminating operations would lead toward abandonment and possible disposal of all or portions of the entire system. The abandonment procedures used would be subject to appropriate existing local, state, and federal regulations.

Port and Onshore Storage Facilities. Should abandonment procedures be implemented at the port, some components at the tanker berthing structures would probably not be taken out of service. The disposition of the cargo handling equipment, submarine pipelines, and support facilities would depend upon abandonment procedures and modified future uses of the facilities. Crude oil remaining in the system would be drained to the onshore storage facility, the equipment disconnected, sealed, secured, and possibly removed for salvage.

Abandonment of the onshore storage facility would require storage tanks to be dismantled and disposed of. All oil and other combustible materials would be removed.

Pipeline System. If the pipeline system were abandoned, removal of the crude oil from the pipeline could be accomplished by displacing it with water obtained from local sources along the route. Selected pumping units would be used to gradually displace the oil and water into delivery facilities. If removal of the water from the system were required, truck transport would be used to deliver the water to oil-water separators. Retaining water in the pipeline system would require addition of a corrosion inhibitor.

Removal and salvage of the pipe and main line valves would require activities similar to construction of the system but with a simplified work scope. Some sections of pipeline might not be removed; for example, river or road crossings. The ends of the pipeline on both sides of the crossing would be sealed and covered with soil. Additional backfill might be required to restore the right-of-way to its original condition. The pipeline cathodic protection system would be disconnected and removed in the event of removal and salvage of the pipe. Main line pumps and motors would be disconnected and either stored or removed for other uses.

Abandonment procedures for the pump stations and delivery facilities would begin after the entire system had been completely evacuated of oil. Disposal and salvage of equipment located at these facilities would be required.

Support facilities included in abandonment procedures include buildings and vehicles and maintenance, communication and control, security, fire protection, oil cleanup, and electrical support equipment. These items would be taken out of service, sold or salvaged.

Cost Estimates

The project cost estimate summary is shown in table 1.2-14. More detailed cost estimate summaries are presented in tables 1.2-15 to 1.2-18.

TABLE 1.2-14 SUMMARY COST OF THE NORTHERN TIER PIPELINE SYSTEM
(Thousands of Dollars, May 1978 Price Levels)

	Initial Phase (709,000 bpd)	Ultimate Phase (933,000 bpd)
Construction cost 1/		
Port	$ 58,917	$ 58,917
Submarine pipelines	28,021	28,021
Onshore storage facilities	52,941	62,538
Pipeline system - Port Angeles to Clearbrook	1,060,806	1,074,342
	$1,200,685	$1,243,818
Annual operating cost 2/		
Marine terminal	$ 4,139	$ 4,892
*Pipeline system—Port Angeles to Clearbrook	45,439	59,250
Total	$ 49,578	$ 64,142

Source: NTPC 1978 (rev. March 1979)

1/ Construction cost includes contingencies, taxes, environmental studies, engineering, and construction management, but excludes interest during construction, escalation, cost of line fill (12,629,000 barrels), and working capital and debt expenses.

2/ Operating cost based on power requirement for pumping 100 percent Alaskan crude.

Construction Costs

A cost analysis of the pipeline proposal was made by the Department of Energy. The analysis concluded that the construction cost figures (January 1977 basis) presented by the applicant tend to be conservatively high thus reducing the likelihood that actual costs would grossly exceed estimated costs. The analysis found that line pipe (43.3 percent of total cost) was apparently estimated at list prices without allowance for discounts which are normal in the industry. Installation labor (6 percent of total cost) was estimated from contractor estimates which are likely to be significantly higher than winning bids. The costs of pumping equipment and tankage were also found to be conservatively high.

TABLE 1.2-15 COST ESTIMATE SUMMARY OF PORT FACILITY
AND SUBMARINE PIPELINE
(Thousands of dollars, May 1978 price level)

Description	Initial Phase1/ (709,000 bpd)
Fixed berths	
Basic structures	$12,223
Utilities	2,792
Miscellaneous	135
Oil-spill containment	825
Subtotal	$15,975
Loading arms and pier piping	3,088
Submarine pipelines	
2-48-inch lines, 5.2 miles in length	28,021
Relocate existing facilities	3,000
Booster pump station	
2-10,000-HP electric-driven pumps,	
Platform and associated facilities	9,038
Metering facilities	2,430
Fuel bunkering system	8,465
Subtotal	$70,017
Contingencies and omissions at 10 percent	7,002
Subtotal	$77,019
Sales and use tax at 5.0 percent	3,928
Environmental studies, engineering and construction management	5,991
Total	$86,938 2/

Source NTPC 1978 (rev. March 1979)

1/ No additional construction would be required for ultimate phase (933,000 bpd).

2/ Cost of line fill (184,000 barrels) not included in this estimate.

TABLE 1.2-16 COST ESTIMATE SUMMARY OF ONSHORE STORAGE FACILITIES--GREEN POINT
(Thousands of Dollars, May 1978 Price Levels)

Description	Initial Phase (709,000 bpd)	Ultimate Phase (933,000 bpd)
Land (242 acres)	$ 1,137	$ 1,137
Pipe	1,250	2,138
Valves and fittings	2,670	4,020
Construction	2,496	3,636
Buildings	564	564
Electrical equipment	1,074	1,578
Tanks	30,314	50,256
Supervisory and communication	748	748
Vehicles and other work equipment	132	132
Auxiliary systems and miscellaneous	1,982	2,596
Subtotal	$42,367	$66,805
Contingencies and omissions at 10 percent	4,237	6,681
Subtotal	$46,604	$73,486
Sales and Use Tax at 5.1 percent	2,377	3,748
Environmental studies, engineering, and construction management	3,960	5,304
Total	$52,941	$82,538

Source: NTPC 1978

TABLE 1.2-17 COST ESTIMATE SUMMARY OF TYPICAL PUMP STATION1/
(Thousands of Dollars, May 1978 Price Levels)

	Station on 42" Line Segment	Station on 40" Line Segment
Pipe and pipe coating materials	$ 38	$ 37
Valves and fittings	678	626
Construction	298	278
Buildings	62	62
Pumping equipment	452 2/	343 3/
Other station equipment	1,294	809
Total	$2,822	$2,155

Source: NTPC 1978

1/ Based on costs for initial capacity of 709,000 bpd for station without scraper traps and with relief tank and excluding contingencies, taxes and engineering.

2/ 11,000 installed horsepower.

3/ 8,000 installed horsepower.

TABLE 1.2-18 COST ESTIMATE SUMMARY OF PIPELINE, STATION, AND DELIVERY FACILITIES1/
(Thousands of Dollars, May 1978 Price Levels)

Description	Initial Phase (709,000 bpd)	Ultimate Phase (933,000 bpd)
Right-of-way and land	$ 26,500	$ 26,500
Pipe (690,336 tons)	416,705	416,705
Main line block valves	11,528	11,528
Pipeline construction2/	383,029	383,029
Pump stations	50,119	61,737
Delivery facilities	18,186	18,186
Supervisory and communications system	2,559	2,559
Vehicles and work equipment	1,272	1,272
Miscellaneous	571	571
Subtotal	$ 910,469	$ 922,087
Contingencies and omissions at 10 percent	91,047	92,209
Subtotal	$1,001,516	$1,014,296
Sales and use tax	26,841	27,183
Environmental studies, engineering and construction management	32,449	32,863
Total	$1,060,806	$1,074,3423/

Source: NTPC 1978 (rev. March, 1979)

1/ Cost of line fill (12,445,000 barrels) not included in this estimate.

2/ The submarine pipeline portion included in the total is estimated to be $73,137,000.

3/ The additional cost of $12,274,000 for the ultimate phase represents pump station modifications.

Annual Operating Costs

Estimated annual operating costs are shown below in table 1.2-19.

TABLE 1.2-19 ESTIMATED ANNUAL OPERATING COSTS2/
(Thousands of Dollars, May 1978 Price Levels)

Item	Port and Onshore Storage Facilities		Pipeline, Station and Delivery Facilties	
	709,000 bpd	933,000 bpd	709,000 bpd	933,000 bpd
Salaries and Benefits	1,011	1,011	2,524	2,524
Power Cost1/	263	339	11,356	21,182
Maintenance	265	388	3,327	4,135
Insurance	244	299	204	235
Ad Valorum Taxes	1,919	2,354	24,197	24,506
Miscellaneous Expenses	437	501	3,831	6,668
Totals	4,139	4,892	45,439	59,250

Source: NTPC 1978 (updated May, 1979)

1/ Power cost based on pumping 100 percent Alaskan crude.

2/ See table 1.2-14.

Tariff Estimates. Department of Energy cost analysis developed tariff estimates presented in table 1.2-20. Because of uncertainties in how rates would be set, DOE utilized both the Interstate Commerce Commission (ICC), and Federal Power Commission (FPC) methods. Regulation of pipeline tariffs was shifted from the ICC to the Federal Energy Regulatory Commission (FERC), formerly the FPC in October 1977. By using both methods a range of the estimated tariff rates is presented.

The rates were estimated assuming the system would operate at 100 percent load factor (system design volumes would be delivered every day of the year). Although unrealistic, pipelines generally operate at load factors in the 95 to 98 percent range, this assumption facilitates comparison of alternative systems.

While the cost analysis concluded that NTPC's cost figures appeared to be conservatively high, DOE estimates of revenue requirements and tariff rates are somewhat higher than the NTPC projections also shown on table 1.2-20. DOE also assumed a 25 year operating life rather than the 20 year life specified.

Tariff estimates presented in Table 1.2-20 were based on early NTPC project cost estimates. Because of subsequent pipeline route and other design changes in the proposal the most recent estimate prepared in March 1979, using May 1978 price levels, indicates a project cost of $1.2 billion, which is a 26 1/2 percent increase over the project cost used in calculating the tariff estimates.

TABLE 1.2-20 TARIFF ESTIMATE1/
(January 1977 Dollars)
Tariff Per Barrel2/

Delivery from Port Angeles, Washington to:	Tariff per Barrel2/ NTPC Estimate	DOE Estimate
Glacier Pipeline, Harlowton, Montana	.54	.54 - .57
Western Crude Pipeline, Riley, Montana	.64	.70 - .74
AMOCO Pipeline, Tioga, North Dakota	.75	.77 - .80
Minnesota Lakehead Pipelines, Clearbrook, Minnesota	.90	1.01 - 1.05

Source: Department of Energy, February 1979
1/ See text for discussion of qualifications of estimates.
2/ Based on initial (709,000 bpd) throughput, using both ICC and FPC methods and assuming 100 percent load factor.

Transportation Costs To Selected Refining Areas. Pipeline transportation costs to selected points were also developed in the Department of Energy (1974) analysis. The tariff estimates used for the proposed NTPC pipeline in these computations are based on 709,000 bpd with an 8 percent return on valuation. Tariffs for existing pipelines are 1977 rates (shown with the pipeline name). Transportation costs shown are cost per barrel from Port Angeles to point indicated, including tariff for NTPC as shown in the table above plus the additional pipeline tariff required as shown for each delivery point:

Casper, Wyoming (via Continental Pipeline, $0.80)	$1.35
Billings, Montana (via Continental Pipeline,$0.45)	1.00
Osage Station, Weston County, Wyoming (via Butte Pipeline, $0.34)	1.04
Mandan, North Dakota (via Amoco Pipeline, $0.12)	.89
Minneapolis, Minnesota (via Minnesota Pipeline, $0.17)	1.18
Superior, Wisconsin (via Lakehead Pipeline, $0.13)	1.14
Chicago, Illinois (via Lakehead Pipeline, $0.29)	1.30
Tonawanda, New York (via Lakehead Pipeline, $0.54)	1.55

Abandonment Costs

Estimates have not been made of the expense required to abandon the proposed system. Such expenses are included in the Interstate Commerce Commission rate method, but were not included by DOE in their tariff estimates (hence, they are not reflected in table 1.2-21). If a dismantling fund is required it would add to the transporation cost. In the case of the Trans Alaska Pipeline System this charge in the tariff is 9.6 cents per barrel.

Net Energy Balance

The net amount of energy which would be delivered by the pipeline has been estimated on a preliminary basis by the Department of Energy. This estimate represents the difference between the energy value of the crude petroleum delivered over the 20-year project life and the energy consumed from national supplies in tanker fuel and construction and operation of the pipeline. The estimate includes indirect energy consumption represented by the energy used in producing the fuels and electricity used directly, the energy used to produce the materials and equipment used in construction and operation, and a pro-rata share of the energy required to produce the capital equipment used in manufacturing equipment for construction and operation of the pipeline system. Tanker fuel represents the roundtrip requirements for tankers transporting Alaskan crude and one-way (return voyage) requirements for ships transporting foreign origin crude oil. The estimates are shown in table 1.2-21.

As with the preceding discussion of tariff estimates, DOE's calculation of the Net Energy Balance as presented here, is based on an early stage of project design. Subsequent changes have generally increased project material requirements while lessening pipeline length so that the net energy balance of the present proposal is not likely to differ significantly from that shown in table 1.2-21.

TABLE 1.2-21 NET ENERGY BALANCE (20 YEAR PROJECT LIFE)

	Unit	Amount	BTU per Unit	Primary Energy Coeff.1/	Energy Equivalent (Million BTUs)
Crude petroleum delivered	bbl.	6,402,100,000 2/			35,669,076,076
Consumption					
Tanker fuel	bbl.	82,342,175	6.3MM	1.2227	634,282,579
Construction materials	ton	846,632	3/	3/	82,817,445
Pump and motor units	ton	1,765	120MM	1.0000	211,800
Fuel used in construction	bbl.	3/	3/	3/	3,745,396
Power, port facility	kWh	816	3.412	4.0683	11,326,928
Power, main line stations	kWh	37,056.2	3.412	4.0683	514,375,803
Power, emergency generators	bbl.	3,057	5.9MM	1.2227	22,052
Total consumption					1,246,024,791
Net energy delivered					34,423,051,285

Source: Department of Energy October 1978

1/ The primary energy coefficient is a factor representing the total amount of energy consumed in producing the direct energy used.

2/ Energy equivalent was computed for each kind of petroleum at BTU equivalents ranging from 5,262,500 to 5,675,500 BTUs per barrel.

3/ Various factors were used in detailed calculations. Energy coefficients for construction materials ranged from 1.44 million BTUs per ton for concrete to 131. million BTUs per ton for copper. For construction fuel, separate estimates were made for gasoline, diesel and propane.

Bbl = Barrels
KWH = Kilowatt hours
BTU = British thermal units
MM = 1 million

Contingency Plans

NTPC will be required to prepare a spill contingency plan to be reviewed and approved by appropriate government agencies prior to initial operation of the pipeline. The plan, required by the Department of Transportation, would facilitate a quick response to system failures or accidents such as oil spills or fires. The details of the plan would reflect the final route location and facilities siting decisions, and identify the leak and fire detection systems which are developed.

NTPC has prepared a draft contingency plan. Figure 1.2-11 illustrates the alert and notification procedure NTPC proposes. Figure 1.2-12 lists the draft contingency plan table of contents.

Alert and Notification Procedure For NTPC System

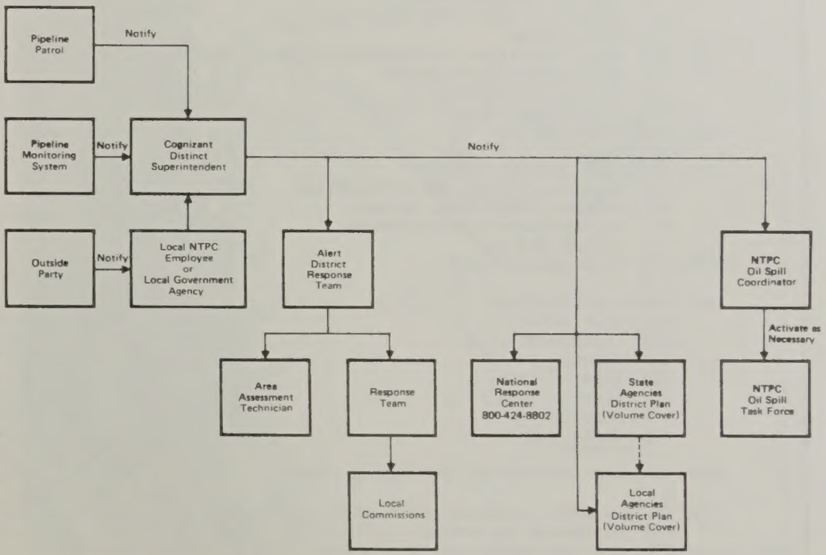

Pipeline Patrol
Notify
Pipeline Monitoring System
Notify
Cognizant Distinct Superintendent
Notify
Outside Party
Notify
Local NTPC Employee or Local Government Agency
Alert District Response Team
NTPC Oil Spill Coordinator
Activate as Necessary
Area Assessment Technician
Response Team
National Response Center 800-424-8802
State Agencies District Plan (Volume Cover)
NTPC Oil Spill Task Force
Local Commissions
Local Agencies District Plan (Volume Cover)

Figure 1.2-11

Source: Northern Tier Pipeline Company

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- 210 Support Manager
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- A. Regulatory Agencies and Regulations
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- E. Documentation and Monitoring
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- G. Oiled Bird Rehabilitation
- H. Block/Check Valve Locations
- I. Behavior of Spilled Oil
- J. Organization and Scope of District Plans

Figure 1.2-12

Source: NTPC

1.3 Proposal of Northwest Energy Company

Northwest Energy Company (NEC) applied on December 8, 1978, under Title V of Public Utility Regulatory Policies Act (PURPA) of 1978, to construct and operate a common carrier crude oil transporation system between Skagway, Alaska, and Keg River, Alberta, Canada.

Existing oil pipelines originating in Keg River would transport additional crude oil from Keg River to Edmonton, and to most northern tier and inland states.

For this project NEC is in partnership with the White Pass and Yukon Corporation, owner of White Pass and Yukon Route, and Foothills Oil Pipe Line, Ltd.

NEC proposes to transport foreign crude oil and Alaskan north slope crude oil to Skagway by tankers. From Skagway to Keg River, approximately 710 miles, NEC proposes to construct a crude oil transportation pipeline system having a throughput capacity of 530 000 barrels per day. Ultimate throughput capacity proposed would be 750,000 barrels per day. The 696-mile Canadian portion of the proposal is sponsored by Foothills Oil Pipe Line, Ltd., and the 14-mile U. S. portion by NEC (see fig. 1.3-1).

NEC proposes to construct an offloading port and onshore storage facility at Skagway, Alaska, to receive Alaskan north slope and foreign crude oil. From Skagway, 83 miles of 36-inch diameter and 627 miles of 34-inch diameter pipeline would cross the northwest corner of British Columbia to a point in the southern Yukon Territory on the right-of-way of the Alaska Highway Gas Pipeline. From there, the oil pipeline would utilize the gas pipeline corridor and parallel the Alaska Highway for 400 miles to Fort Nelson, British Columbia, then turn east to Keg River, Alberta. From Keg River the existing oil pipeline facilities would need to be expanded to transport the oil to the northern tier and inland states. The majority of new pipeline construction would follow existing railroad, highway, and pipeline rights-of-way.

Tankers from Valdez, ranging from 90,000 to 166,000 dead weight tons, would arrive at Skagway at a rate of about 1 ship every 2 days. Foreign light crude oil tankers would range in size up to 225,000 dead weight tons and would enter the port of Skagway at a rate of about 1 ship every 15 days.

NEC would construct a port facility to receive 225,000 dead weight ton tankers along the eastern shore of Skagway harbor, south of an existing freight wharf owned and operated by White Pass and Yukon Route. A 42 inch underground pipeline would transport 48,000 barrels per hour a distance of 3.5 miles to the onshore storage facility in the northwestern part of Skagway. The storage facility would consist of eight 510,000-barrel capacity storage tanks, a pump station, and associated support buildings. From this onshore storage facility a 36-inch buried pipeline would run approximately 14 miles in a northeasterly direction to the border of Alaska and Canada. The pipeline would closely follow the White Pass and Yukon Route's railroad right-of-way with only two deviations (see figure 1.3-2). The right-of-way would be widened to accommodate both the railroad and pipeline. The operations headquarters for the entire proposed pipeline would be in Skagway.

One major pump station would be constructed at Skagway. Pipeline construction would include placing main line block valves at various locations. The 36-inch to 34-inch main line would have a design capacity of 530,000 barrels per day, which is equivalent to an average annual throughput volume of 500,000 barrels per day. Fire

NEC Total Transportation System

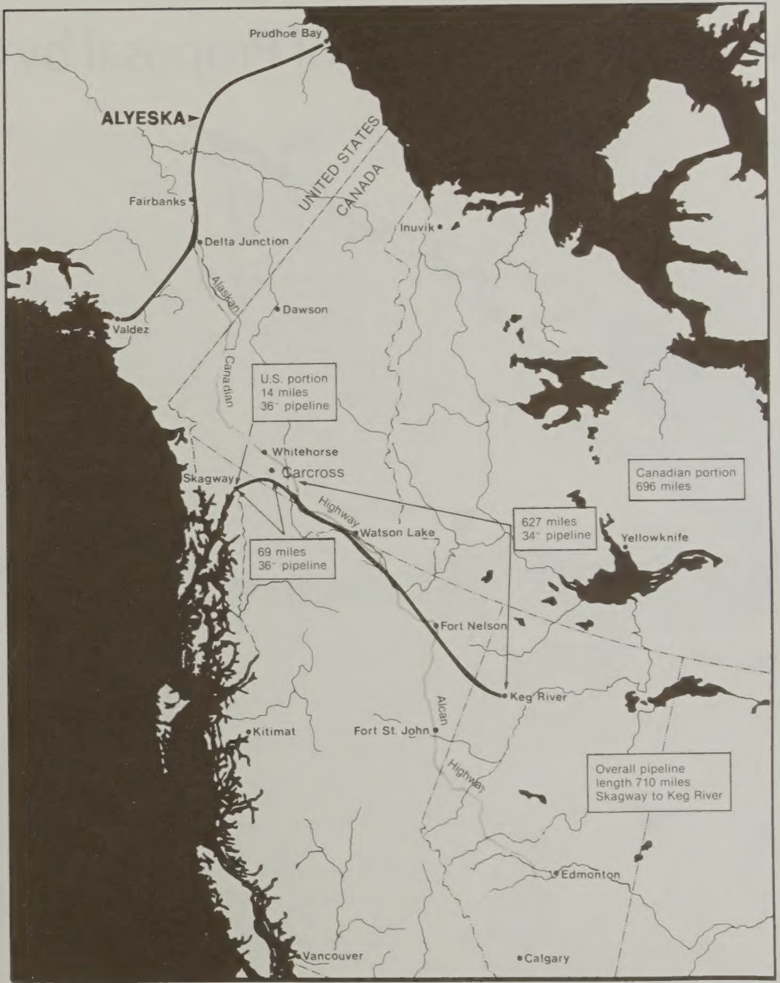


Figure 1.3-1

Source NEC 1979

Map of Alaskan Portion of Proposal by N.E.C.

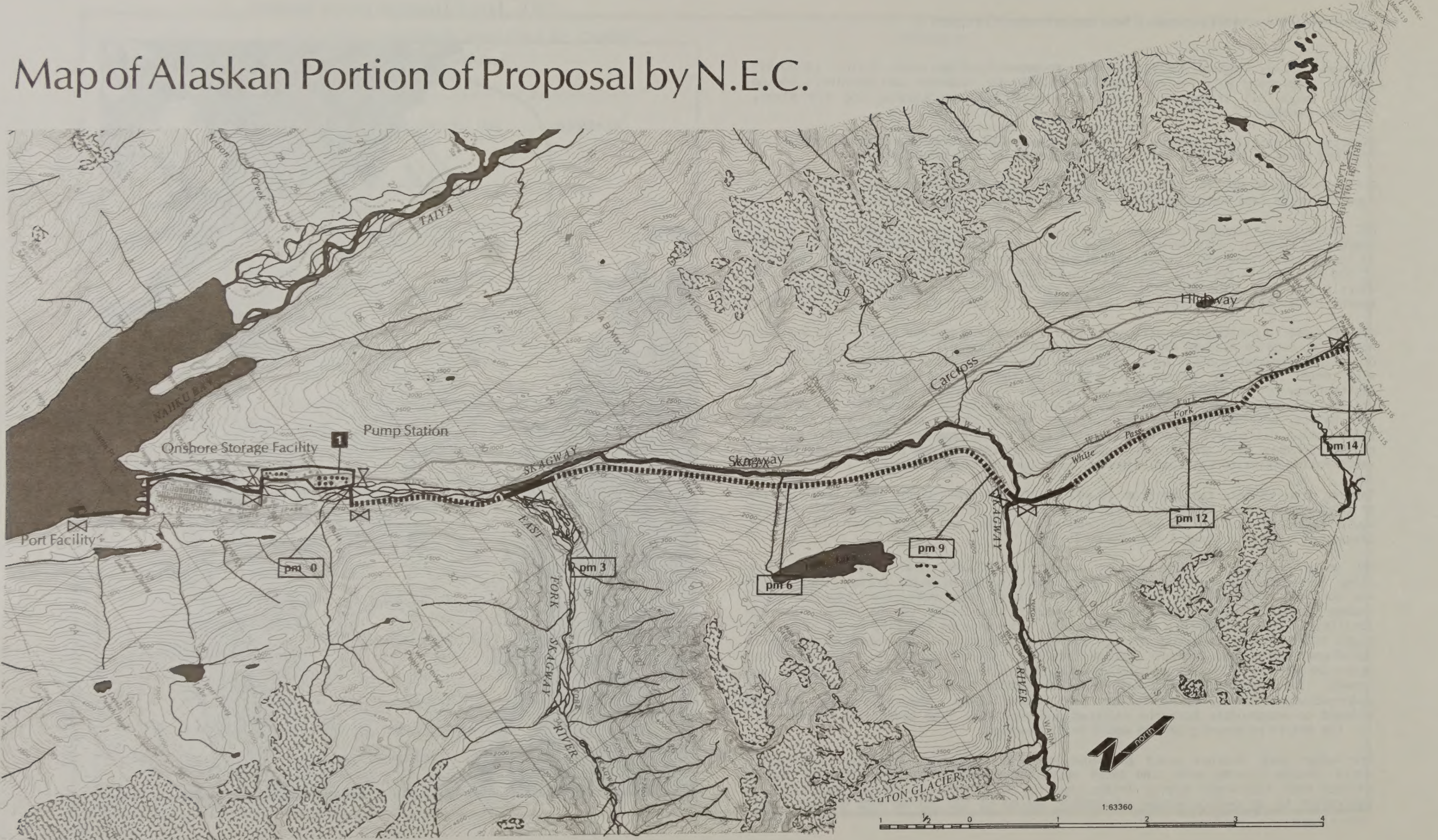


Figure 1.3-2

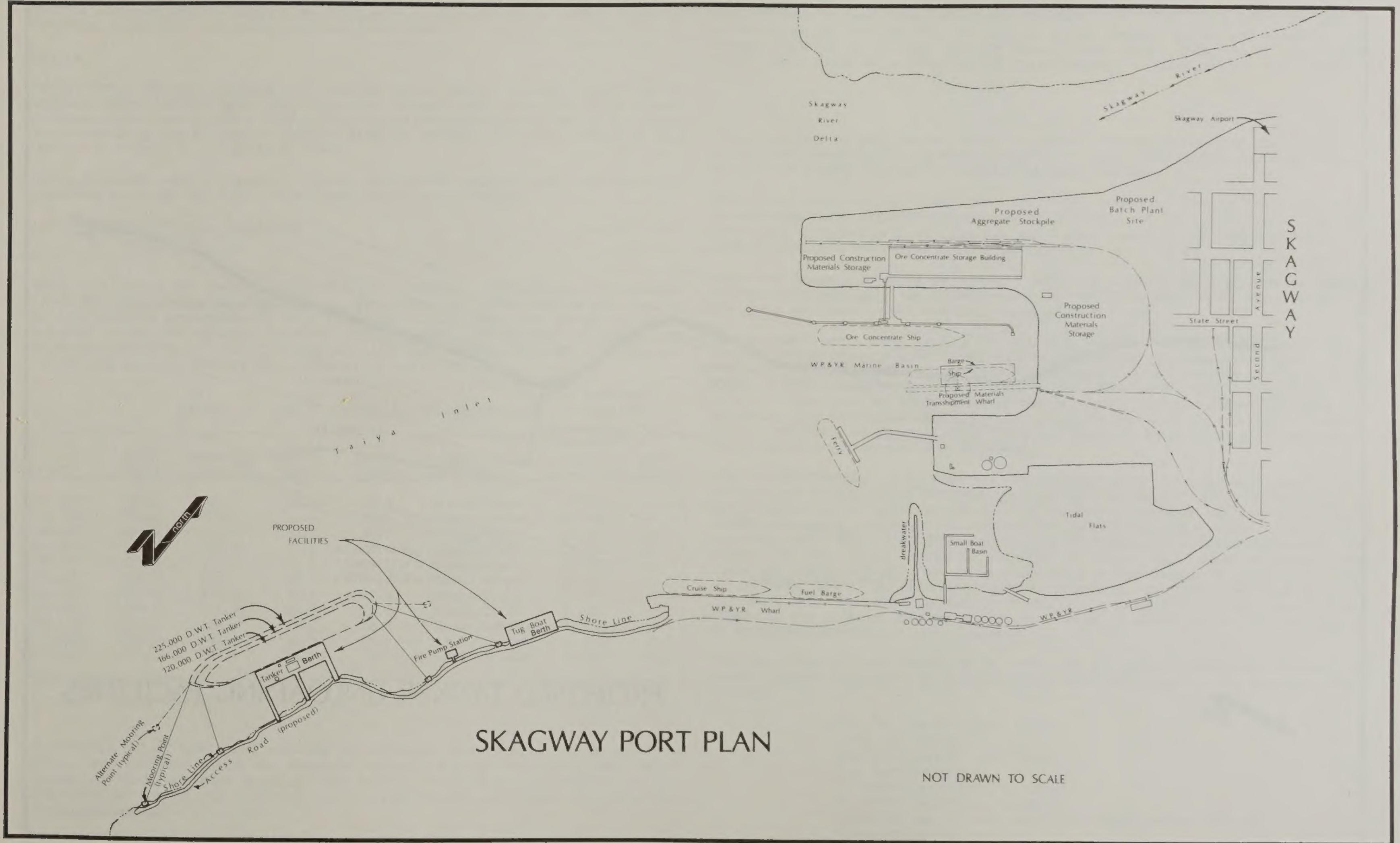
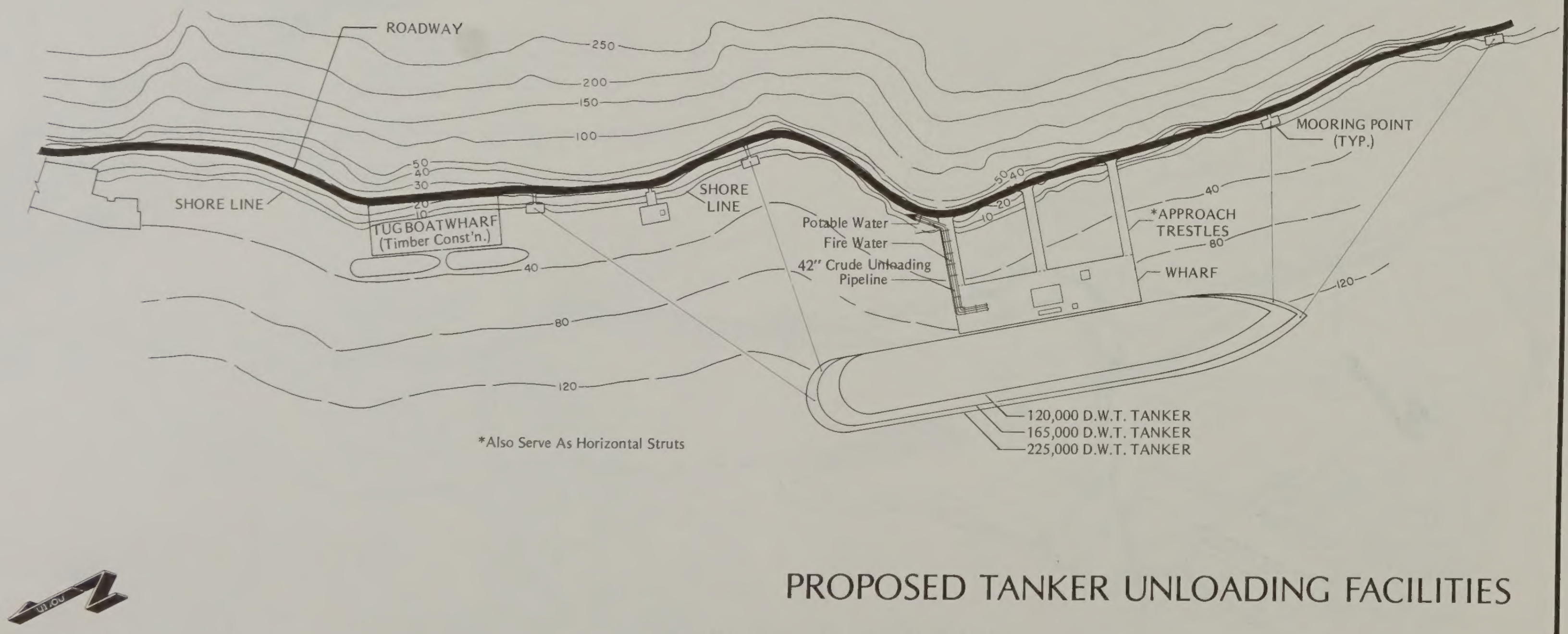


Figure 1.3-3

Source NEC 1979



PROPOSED TANKER UNLOADING FACILITIES

Not Drawn To Scale

Figure 1.3-4

Source NEC 1979

control stations and oil collection, separation, and containment systems would be developed at the port and onshore storage facilities.

Sea Leg

NEC proposes to route tankers 138 nautical miles through Chatham Strait and 81 nautical miles through Lynn Canal (58 miles through Lynn Canal, 12 miles through Chilkoot Inlet, and 11 miles through Taiya Inlet) to Skagway, a total of 219 miles. The distance up the navigation corridor from the entrance of Chatham Strait at Cape Ommaney to Skagway is 201 nautical miles.

NEC's proposed routing generally follows mid-channel courses with some variation depending on the position of lights, buoys, and/or other navaids.

Port and Onshore Storage Facilities

Port

Table 1.3-1 gives the specifications of typical tankers. Dimensions are approximate since the length:beam:depth ratios vary. Each vessel of a given dead weight capacity in the table is an average of main dimensions. A 227,000 dead weight ton (dwt) capacity tanker, for example, is about 1,107 feet long. If assisted by tugs, it can be turned around in a circle approximately 1,500 feet in diameter. NEC indicates the turn-around basin at Skagway has a diameter of 5,470 feet.

TABLE 1.3-1 SPECIFICATIONS OF TYPICAL TANKERS

DWT	LOA1/ (feet)	Breadth (feet)	Depth (feet)	Draft (feet)	Type of Main Engine	Engine Output (horsepower)	Speed (Knots)
57,000	688.8	105.8	53.8	40.5	Diesel/Steam	17,400	16
66,000	748.7	105.8	58.4	43.6	Diesel/Steam	20,000	16
84,000	832.3	112.5	60.7	45.8	Diesel/Steam	20,000	15.5
102,000	871.8	127.9	62.0	48.0	Diesel/Steam	22,500	16
127,000	864.8	133.8	72.8	54.9	Diesel/Steam	23,900	16
140,000	965.5	133.8	70.1	53.7	Diesel/Steam	28,000	16.5
150,000	955.8	167.3	78.7	49.2	Diesel/Steam	25,000	15.5
230,000	1066.0	171.9	81.7	63.3	Diesel/Steam	31,000	15.7
256,000	1049.6	169.9	87.6	68.6	Steam Turbine	31,000	14.8
277,000	1106.7	178.8	91.2	70.8	Steam Turbine	36,000	15.9
300,000	1120.4	175.8	94.1	72.8	Steam Turbine	36,000	15.6

Source: NEC 1979

1/ LOA = Length overall

The Chatham Strait-Lynn Canal waterway has straight, deep waters. At the narrowest point, near Katzehin Flats, the deepwater width is 0.6 nautical miles (3650 feet). Prevailing winds are dead ahead or dead astern. NEC states that tankers up to a 275,000 dead weight ton capacity could safely travel to Skagway on a regular, year-round basis.

NEC proposes to have pilots board and disembark near Sitka. This would not require a deviation or loss of time for tankers moving between Valdez and Skagway. For vessels trading to or from offshore destinations (e.g., Indonesia or the Arabian Gulf) there would be a deviation of approximately 70 miles or 4.6 hours steaming time.

On approaching Skagway tankers would be escorted by two tugs. From the entrance to Taiya Inlet speed would be gradually reduced to ensure that vessels would be underway only to the extent required to maintain adequate steerage.

With tug assistance and short burst propeller movements tankers would be turned around and brought parallel to the berth at a distance of 500 to 700 feet. From this point onward the ship's main engines would not be used. The tugs would push the tankers slowly to the berth, keeping them parallel at all times.

Undocking procedures would be similar. Because tankers would already be heading south, tugs would pull the vessels clear of the berth where they would be able to use their own power to get underway, escorted by two tugs.

The proposed port would include an unloading wharf, located in the southeastern portion of the Skagway harbor, and a separate dock for berthing and servicing three tugboats. A 100 by 400-foot unloading platform would be connected to the shore by three approach trestles extending approximately 150 feet (figs. 1.3-3, 1.3-4, and 1.3-5). The trestles would intersect an elevated roadway constructed along the shoreline from the southernmost mooring point to the existing roadway in Skagway. Final dimensions and orientation of the wharf would be established after engineering investigations of the site were completed.

The platform section would have the characteristics of a barge, with twenty wells in the deck through which 96-inch caissons would be placed. The platform would be prefabricated in two sections (100 feet by 200 feet each) at an off-site shipyard and towed into place complete with caissons and pile-driving gear. The three trestle sections, which serve both as connections to the shore and as horizontal struts that convey the ship impact forces to abutments on shore, would also be prefabricated elsewhere and delivered to the site. The wharf units, once in position would serve as a landing point for incoming equipment, materials, and fabricated tank sections. The wharf sections below the deck would provide a large area of open space, interrupted by the bulkhead support system, that would be available for the installation of equipment, storage, or other purposes.

The unloading platform would be designed to accommodate equipment, piping, and appurtenances necessary to unload crude oil from tankers. The facility would include:

four 16-inch unloading lines;
crude oil strainers;
piping, manifold, and valves;
four turbine meters;
oil-water waste holding tanks;
oil-water separator equipment;
unloading operations control and communication room; and
stevedore operations room.

PROPOSED UNLOADING PORT

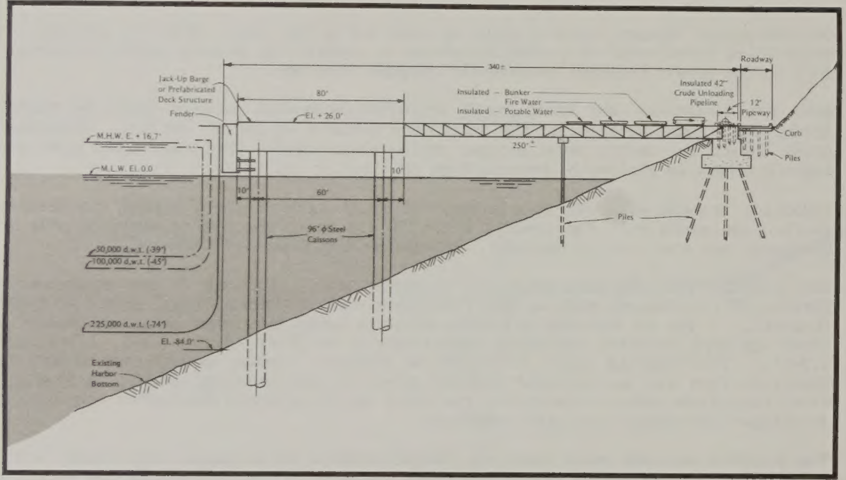


Figure 1.3-5

Source NEC 1979

A separate building on the wharf would contain controls required to actuate the port crude oil unloading arms. The arms, supported on a tower, would be equipped with quick-disconnect ends.

A communication system would interconnect the port facility with the onshore storage facility, block valves, pump station, and the marine and mobile radio system in the Skagway area. Potable water from the onshore storage facility would be supplied by water main. It would service stevedore facilities and ship water tanks and would supply recirculating, fresh water to the pipe loop of the sea water fire protection system.

A small diesel electric plant would be located at the port facility to provide emergency power.

Sewage would be accumulated in holding tanks and disposed of by septic tank purifiers.

Three tugs, each with a minimum 60-ton bollard pull (deadweight pull) capacity, would be available for docking and fire protection services. A separate dock, located approximately 500 feet south of the existing general cargo wharf, would be provided for berthing and servicing of two tugs, with the third tug brought alongside the berthed tugs. The tugs and line handling launches associated with docking operations would be supplied under contract.

Fire protection at the port facility would be provided by both onshore and offshore support systems. A series of fire pumps with both sea water and foam delivery capabilities would be installed onshore adjacent to the facility and on the unloading platform. Fire mains and hydrants would be located along the approach trestles and on the unloading platform. Two 2,000-gallon per minute capacity fire pumps would be installed on the three tugs proposed for use in berthing the tankers. The tugs would be manned by a crew of eight; at least three crew members would be trained in the tug's fire fighting system.

Buildings at the port facility would be equipped with smoke and heat detectors. An automatic visual and auditory alarm system would provide immediate warning in the terminal area, at the tug dock, administration headquarters, and the Skagway Fire Department. Manual alarms would also be installed. Automatic sprinkler systems would be installed in heated buildings. Dry-type or halon systems would be installed throughout the port area where explosive mixtures of hydrocarbon vapor could occur.

All facilities and structures at the port facility, including incoming electric and communications services, would be protected by lightning arrestors.

The port facility would be enclosed by security fences with guard houses at entrance and exit locations. There would also be a guard house on the unloading wharf. Regular security patrol patterns would be established and auditor alarm systems would be installed in buildings and on tugs. A loudspeaker and telephone system would be established between onshore guard houses and vessels when at berth.

Ships offloading crude oil at Skagway would require a supply of bunker fuel for the outbound voyages. Such fuel would come from the west coast and be stored in the Skagway area. The supply company would dispatch a fuel barge from its base. NEC has not indicated specifics of the bunker fuel service, including sulfur content, cost, storage, and handling procedures.

Unloading Line

The unloading pipeline would be 42 inches in diameter, 3.5 miles long, and would transport oil from the port to the storage tanks.

The unloading pipeline, fire mains, and utilities from the platform to shore would be supported on the wharf roadway trestles. The pipe support areas would be curbed. Onshore, the pipeline would be buried. The final locations of the pipeline on shore would be determined after detailed surveys were made.

Approximately 400,000 barrels per day of Prudhoe Bay oil and 100,000 barrels per day of offshore oil would be unloaded daily. By the addition of booster pumps these volumes of oil could be increased to approximately 800,000 barrels per day. The unloading pipeline would be capable of moving approximately 48,000 barrels per hour or 1,152,000 barrels per day. Four turbine meters and one spare would be installed in the piping system at the wharf platform to measure and record crude oil quantities unloaded. Under control by a real time minicomputer, meter information would be displayed in the operations control center.

Leak Detection System. When tankers were not unloading the static pressure in the unloading line would be monitored at the wharf and telemetered to the control center computers. Any abnormal reduction in pressure would indicate a leak and the supervisory master would alert the operator and recommend corrective action. NEC anticipates that leaks as small as 0.3 percent of the content of the line could be detected during static conditions.

When tankers were unloading, the flow rates out of the unloading manifold and into the onshore storage manifold would be telemetered to the control center computers. Any abnormal discrepancy in the flows would indicate a leak. The supervisory master would alert the operator and recommend corrective action. NEC anticipates that a leak of 0.5 percent of the unloading line flow would be detectable a few minutes after its occurrence.

Control Valves. Control valves would be motor operated on crude oil piping on the unloading platform, on the 42-inch unloading pipeline on shore, on either side of the Skagway River crossing, and in the onshore storage facility. Power would be supplied from the base power plant. The valves on the unloading platform would be operable from the central building on the platform and from the supervisory control center at the onshore storage facility.

Control valves at the Skagway River and in the onshore storage facility would be operable from the supervisory control center. The valves would shut down in sequence to prevent fluid hammer damage. All valves would be equipped to be manually operated if required in the event of a power control failure.

Onshore Storage Facility

The onshore storage facility would be constructed on approximately 62 acres of an existing storage site northeast of Skagway, on the west side of the Skagway River. About 11 additional acres of land would be required for the onshore storage facility.

Description of Facility. The proposed onshore storage facility would include eight 510,000-barrel fuel storage tanks with steel containment dikes, mainline pump station building, metering and prover station platform, booster pumping station building, diesel power plant, fire station, maintenance building, the central control and administration building, and facility appurtenances (see fig. 1.3-6).

Four of the 21 existing tanks on the site would be retained and refurbished as water supply tanks for the fire protection system.

Storage for three million barrels of Alaskan North Slope heavy crude oil and one million barrels of offshore oil would be provided in the eight 510,000-barrel tanks. Each storage tank would be 250 feet in diameter and 62 feet high. Each tank would have double deck floating roofs and primary and secondary sealing devices. Cathodic protection would be provided for buried piping and tank bottom surfaces. The interior surfaces of the storage tanks would be coated to resist corrosion.

Floating roofs would be capable of supporting a 10-inch rainfall in a 24-hour period with the primary drainage system inoperative. The floating roof would be equipped with a 4-inch minimum primary drain.

Nozzles would be provided for installation of electric motor driven tank mixers required to minimize accumulation of bottom sediment deposits.

The proposed tanks would be designed to withstand a 100 mile per hour wind and to resist seismic risk zone 3 forces assumed to act non-concurrently in the direction of each of the main axes of the tank structure.

The liquid level gauge and high level switches in each tank would transmit a signal to the control center where readouts of tank levels would be provided. The safety system would include a warning system and automatic shutoff when tanks reach high level marks. An alarm system would alert operating personnel at both the unloading wharf and the storage facility.

The pipe systems would include tank fill and pump suction systems, water draw-off system, roof drain system, and dike drain systems.

Two tank fill mains and two pump suction mains would run underground between the storage tanks. A two-pipe system would be used for heavy and light crude oil and would allow for storage of either in any tank. The two tank fill mains would be connected to the tanker unloading pipeline at the incoming scraper trap.

Oil Separation and Containment. Each tank would be surrounded with a steel dike capable of containing the volume of the tank plus two feet of freeboard. The outside shell diameter of the dike wall would be 340 feet and the dike wall would be about 35 feet high. The bottom of the containment would be concrete at least 4 inches thick and sloped for drainage. Access to the space between dike wall and storage tank wall would be by leaktight steel doors on the lower shell of the dike wall and by steel stairways.

Reinforced concrete ring wall footings would be utilized for tank shells and containment dikes. The footings would be designed for foundation and seismic conditions at the site. Tank sub-bases would be graded and prepared with a layer of granular material treated to meet corrosion prevention requirements, and compacted for required bearing pressures to support the loaded tanks.

PROPOSED ONSHORE STORAGE FACILITY

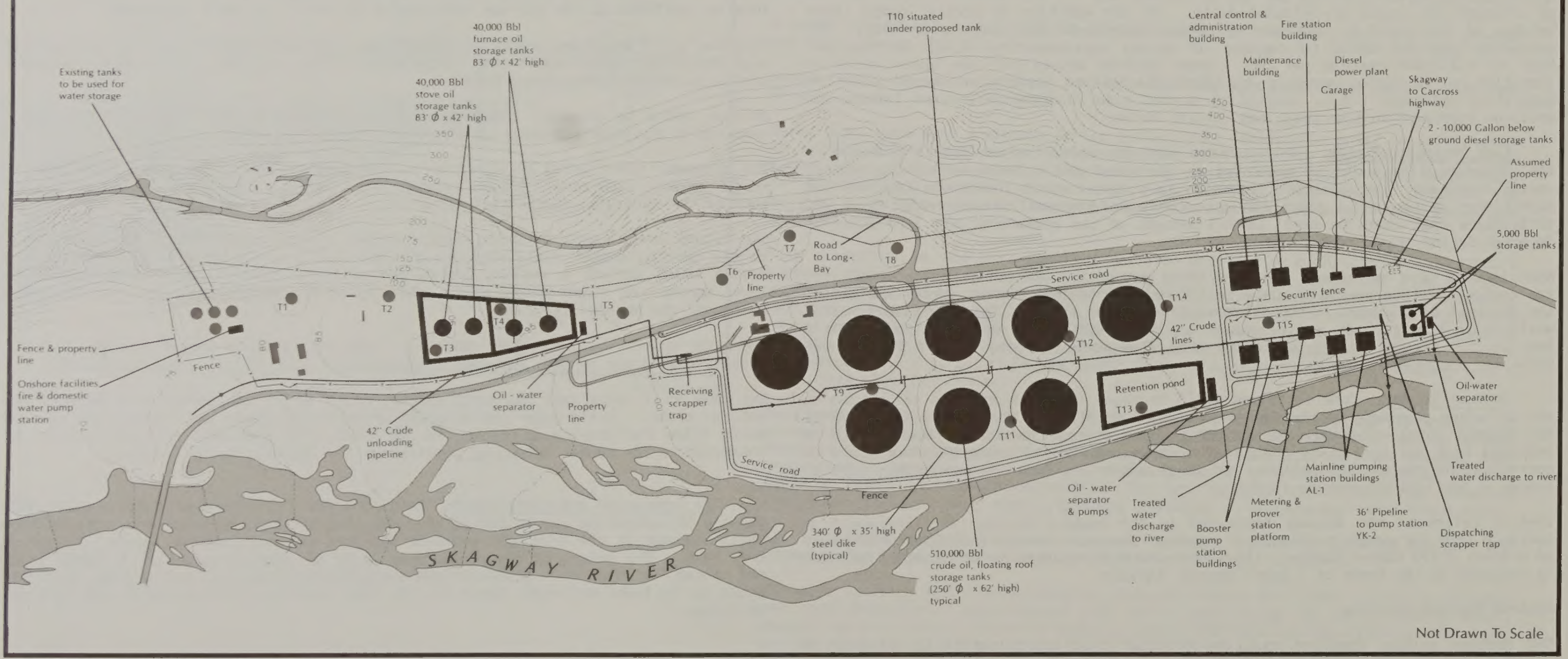

Existing tanks to be used for water storage
40,000 Bbl stove oil storage tanks 83' Ø x 42' high
40,000 Bbl furnace oil storage tanks 83' Ø x 42' high
T10 situated under proposed tank
Central control & administration building
Fire station building
Maintenance building
Diesel power plant
Garage
Skagway to Carcross highway
2 - 10,000 Gallon below ground diesel storage tanks
Assumed property line
5,000 Bbl storage tanks
Fence & property line
Onshore facilities fire & domestic water pump station
Fence
T1
T2
T3
T4
T5
T6
T7
T8
T9
T11
T12
T13
T14
T15
Property line
Road to Long-Bay
Service road
Security fence
42" Crude lines
Retention pond
Oil - water separator
Property line
Receiving scrapper trap
42" Crude unloading pipeline
Service road
Fence
340' Ø x 35' high steel dike (typical)
510,000 Bbl crude oil, floating roof storage tanks (250' Ø x 62' high) typical
Oil - water separator & pumps
Treated water discharge to river
Booster pump station buildings
Metering & prover station platform
Mainline pumping station buildings AL-1
36' Pipeline to pump station YK-2
Dispatching scrapper trap
Treated water discharge to river
Oil-water separator
SKAGWAY RIVER
350
300
250
200
175
150
125
100
450
400
350
300
250
200
150
125
Not Drawn To Scale

Figure 1.3-6

Source NEC 1979

The final design of the proposed steel dikes would be analyzed by computer for dynamic response to earthquakes. The analysis would include the range of ground acceleration, displacement, and hypothetical duration.

The peripheral roadway around the entire storage facility would be elevated to afford an additional retention area to contain the volume of crude oil from a single storage tank.

An oil-contaminated rainwater collector, oil spill interceptor, and reclaiming system would serve the onshore storage facilities.

An oil-water separator and retention pond would be installed in the storage area. Another oil-water separator would be installed in pump station AL-1. Small oil spills from storage tanks, piping, and valves would flow directly to the oil-water separators. Reclaimed oil would be pumped back into storage and the water discharged into the Skagway River.

Rainfall runoff collected from storage tank roofs and dike areas would be collected and piped to the retention pond and then routed to the oil-water separator for disposal.

Storage tanks would be equipped with drawoff outlets and valves to automatically drain bottom water from the tanks into the retention pond.

The oil spill and storm water collection system would consist of underground branch connections from storage tank roof drain outlets, storage tank water drawoff outlets, containment area drainage outlets, pipe and valve curbs, and slop pans; these would be connected to mains running to the retention pond.

A communication system would interconnect the port facility, onshore storage facilities, block valves, pump station, and the marine and mobile radio system in the Skagway area. The control center would be located in the administration building within the onshore storage facility. It would also be the terminus of the communications network serving the pipeline in Canada. A microwave system would be constructed from Skagway to join the Canadian National Telecommunications system in Yukon Territory.

A private electronic telephone exchange would be located in the administration building. It would connect telephones in administrative offices, control center, port facility, onshore storage area, and pump station. The Skagway area private mobile radio repeater would be interfaced to this exchange to permit users of mobile or portable radios to dial without operator assistance. This exchange would connect to maintenance bases in the Canadian section and to the local public telephone office. An emergency-use party line would connect all major facilities in Skagway with the control center. Remote control and data acquisition equipment at the port facility, onshore storage facility, block valves, and pump station would be connected to the master supervisory control terminal in the control center by a shared data circuit.

A closed circuit television system would be provided for monitoring the unloading platform work area.

NEC states the reliability of the communication system would be 99.9 percent.

Major oil transportation facilities, including tanker port facilities, unloading line, onshore storage facilities, and the pump station and valves, would be remotely monitored and controlled from the Skagway control center. The master supervisory terminal at the control center would be a redundant system of dual mini-computers, a dual control CRT terminal, and dual line printers. The remote terminal units would consist of redundant microprocessor modules.

Electric power would be provided by a primary power diesel electric plant. The plant would consist of four 500 kw generators driven by diesel engines. Two generators would provide for the primary electric power, lighting, control, and communications load, while the other two would allow 100 percent standby capacity. The plant would generate all normal electric power for lighting, controls, communications, and power demands of the port facility, the onshore storage facility, the pump station, and land-based fire protection systems, as well as the oil collection and containment systems.

The power generators would be located in the onshore storage facility site. Above ground power lines would be run between the power plant, the port facility, and the other proposed facilities.

The building housing the generators would be insulated and would have heat detecting and "open flame" fire detecting systems and alarms. Portable dry chemical fire-fighting equipment would be available for electrical fires. Fuel supply for the engines would be contained in two 10,000 gallon underground storage tanks with fuel piping and pumps.

A water storage and distribution system would serve domestic and fire fighting needs of the onshore storage facility. A comprehensive fire sensing and protection system would be installed in the onshore storage facility. Both water and foam delivery capabilities would be available. Fire water storage would be provided by renovating four of the existing 10,000 barrel steel oil tanks located on the site. The four tanks selected would not have been previously utilized for fuel storage. The tanks would be cleaned to bare metal and coated with a corrosion-resistant material. Wells would be drilled in the area for fresh water supply sources. The water would be pumped to circulate and maintain water level in the tanks. Based on existing well yields, NEC expects that wells would usually yield from 300 to 500 gallons per minute.

Two high capacity fire pumps and a booster pump would be installed adjacent to the four storage tanks. The booster pump would deliver water at above 20 pounds per square inch in the distribution system. In the event of a fire, the pumps would supply water demand. The proposed storage would provide a reserve of about 1.5 million gallons and would supply water at 5,000 gallons per minute for 5 hours to meet fire demands.

Water supply would be delivered through a closed loop water main distribution system. Fire hydrants and mains would be located throughout the storage facility. Size of water mains would be based on engineering studies to be performed.

A system for cooling the tank and dike shelter would be provided. This system would involve water sprayed through a series of nozzles installed near the top and on the sides of the tank and dike shelter.

The tanks would be equipped with seal-area foam protection systems. Foam chambers would be installed around the top of tank shells and connected through pipes to foam supply units located outside the dike areas. The floating roofs of the tanks would be equipped with foam dams to concentrate released foam within the sealed area.

Automatic fire sensors would be installed in the tank roof seal areas which would trigger alarms througout the storage facility area. Other auditory and visual alarms, including manual ones, would be located throughout the area and in the administration and control buildings. These buildings would be equipped with heat and smoke sensing devices and automatic sprinkler systems. In addition, a halon gas system would be provided for those buildings housing indoor control and instrumentation equipment. Portable fire extinguishers would be placed throughout the area and in all buildings.

Two utility fire trucks equipped with hose reels, a chemical delivery system, and a high pressure fog system would also be provided. The fire trucks and other large vehicles in the facility area would be capable of towing the foam units. All alarms and fire fighting procedures would be integrated with those of the Skagway Fire Department.

The onshore storage facility would be entirely enclosed by security fences with guard houses.

Pipeline System

Pipeline Route

The underground pipeline would run east from the proposed onshore storage facility at Skagway, cross the Skagway River, and turn north alongside the White Pass and Yukon Route railway close to pipeline mile 1. The railway right-of-way would be widened to accommodate the proposed pipeline.

From this point the pipeline would proceed adjacent to the railway, diverging only at two railway switchbacks. The first switchback would be near pipeline mile 3. The pipeline would proceed north and rejoin the railway right-of-way at pipeline mile 4. At the second switchback, approximately at mile 9, the pipeline would continue in a northerly direction, cross the Skagway River for the second time around pipeline mile 9.5, and rejoin the railway right-of-way at mile 10. The pipeline would cross the Alaska/British Columbia border near pipeline mile 14 at White Pass.

Pipeline

The line pipe between Skagway and White Pass on the Alaska/British Columbia border would be 36-inch outside diameter (OD) x 0.514-inch wall thickness (WT) x Grade X-70, manufactured using the double submerged arc welding process.

The pipe wall thickness would be increased for major river and road crossings. The pipe would be weighted for water crossings.

NEC has indicated that the pipeline would be designed in accordance with the requirements for Seismic Risk Zone 3.

Backfill and burial for the pipeline would be designed to provide protection against ordinary snow avalanches, ice falls, rock falls, and mudslides.

The pipeline system would be protected against external corrosion. Both external coatings and cathodic protection would be applied.

Pipeline leak detection would be part of the supervisory control system. Flow rates at each pump station would be telemetered to the Skagway control center computers. The computers would compare the telemetered flow rates with a mathematical simulation of the pipeline system. A discrepancy would indicate a leak.

Main Line Valves

Block valves would be installed on the main line at approximately 17-mile intervals with a valve at pipeline mile 14. The valves would be remotely monitored and controlled from the Skagway control center. Power to operate block valves would be supplied by nitrogen cylinders. A microwave radio station with mobile radio repeater and supervisory control terminal would be located at each valve site.

Block valves would be installed on both sides of the two Skagway River crossings. A check valve would be installed downstream of each crossing.

Main line block valves would be installed on the suction and discharge of all stations.

Main Line Stations

Eight pump stations would be required for the entire pipeline length. The pipeline capacity could be increased to 750,000 barrels per day by installing an additional pump at each of the eight pump stations and by installing additional pump stations along the route.

The general location of pump station AL-1 in Alaska was chosen primarily on the basis of hydraulic design requirements. The specific location of the pump station AL-1 site was selected on the basis of accessibility, soil characteristics, water table levels, and lack of flooding from the nearby Skagway River.

The major elements of pump station AL-1 would be booster and main line pumps, turbine drivers, valves, a pressure relief system, controls, and turbine fuel storage. The turbine fuel supply would be available from existing tanks located in the onshore storage facility area.

Pump station data, including line pressures, flow rates and temperatures, valve status, and alarms would be displayed on the pump station control panels and in the control and administration building. In periods of normal operation the pump station would be controlled from the supervisory control center. In an emergency the pump station and its valves could be shut down either by operators in the supervisory control center or by pump station personnel. All station equipment would be fully automatic with local manual override.

Electric power for pump station AL-1 would be obtained from the onshore storage facility primary power diesel generating plant. Each pair of booster and main line pump buildings would be provided with an emergency generator of a capacity to generate all electric power required by the pump station. A storage battery would be installed to provide a "no break" supply for the control and communications systems, as well as for emergency lighting.

Distillate fuel for turbines would be stored in two tanks, each having a capacity of approximately one week of demand. The storage would be provided with spill retention dikes. All spills within the retention dikes would be reclaimed.

Buildings where hydrocarbon vapors could be present would be equipped with vapor, heat, and "open flame" fire detecting systems and alarms. Portable dry chemical fire-fighting equipment would also be available in case of an electrical fire.

Delivery Facilities

NEC has not furnished any information concerning the delivery facility at Keg River, Alberta.

Construction, Operation, and Abandonment Phases

Construction Phase

Construction Schedules. The Alaskan portion of the NEC proposal would be scheduled for completion in two years (see fig. 1.3-7).

A minimum of 6 months lead time would be required for procurement of some equipment. The construction equipment, personnel, yards, temporary building, and initial materials would be assembled in Skagway during the first two months. Most of the initial materials and equipment, plus all subsequent shipments, would be shipped by barge to Skagway from west coast ports by licensed carriers. Utilization of conventional cargo vessels would be dependent on their schedules, availability, and tariffs.

The White Pass and Yukon Route controls several parcels of land in and around Skagway. These holdings would be available for use to the extent needed. NEC reports that the parcel containing the existing ore concentrate loading facility is presently under-utilized and could meet the project's construction requirements. The 25-acre site could be used for the construction field office, concrete batch plant, portable rock crusher, equipment and materials yards, and aggregate processing and stockpiling.

Although other White Pass and Yukon Route holdings would be available, the ore concentrate loading facility is proposed by NEC as the initial and primary site for the above listed activities. Later, as the schedule begins to peak, an additional material site would be established on White Pass and Yukon Route's land immediately adjacent to the proposed onshore storage facility. The onshore storage facility materials would be consigned to this site, which affords approximately 14 acres of usable area. In total area (approximately 39 acres) it exceeds the anticipated requirements by roughly 25 percent, including allowances for aggregate and materials stockpiling.

The construction workers' camp would require approximately 7.5 acres of leased or purchased land. This land, located near the onshore storage facility site, is on the north side of the Skagway River immediately downstream from the tanks. The proposed site lies within a 20-year flood plain. The site will be filled with additional fill material so that building floor elevations and accessways would be above existing ground elevations.

The camp would consist of pre-fabricated buildings heated by combination fuel oil burning systems and electric unit heaters. Each building would have a mechanical

PRELIMINARY CONSTRUCTION SCHEDULE

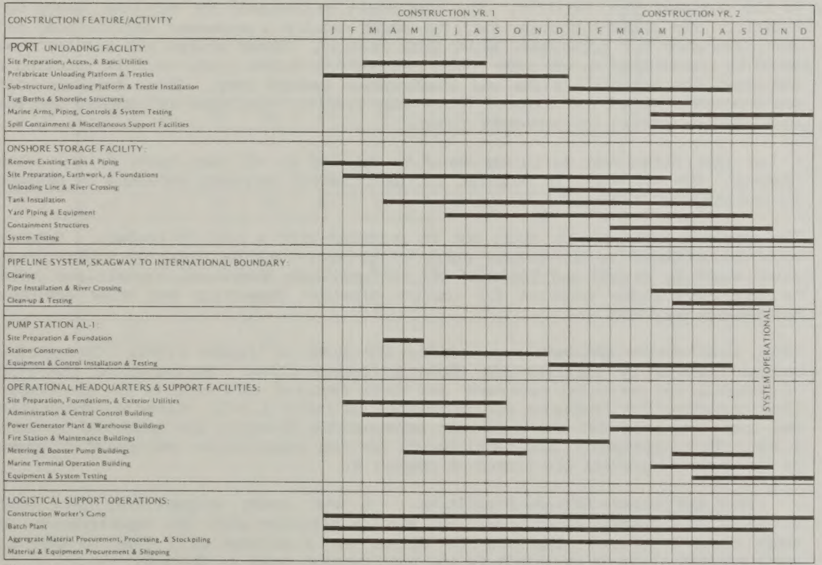


Figure 1.3-7

Source NEC 1979

utility room. The living units would be connected by arctic shelter walkways which would also connect to a central kitchen and dining building, recreation hall, laundry room, and first aid station. Camp staff would be housed within the camp complex in quarters separate from the workers' bunkhouses.

The camp would be provisioned by an established construction camp catering firm whose services would include operation and maintenance of the camp.

The camp would be independent of the Skagway utility systems. It would have its own water and electric power sources, solid waste disposal system, and primary and secondary sewage treatment plant. The proposed construction would require permanent access and service roads as well as temporary access roads for construction.

A 2,000 foot long permanent access road would be constructed from the existing port to the proposed port facility. The road would be designed for two-lane, heavy duty traffic. The onshore storage facility would require a permanent service road network, designed for occasional heavy duty traffic. These access and service roads would be constructed in the same manner. Temporary access roads would be required in and about the materials sites and construction workers camp. These two-lane roads would be constructed for frequent heavy duty traffic. Surfaces and roadbed sections would be the same as for permanent roads.

A low type bituminous surfacing would be applied to all new roads in and around Skagway. The surfacing is required for dust control purposes and would be designed for anticipated loading.

The pipeline right-of-way would not be provided with a vehicle roadway. Measures would be employed to discourage entry of private vehicles into the right-of-way, which would be graded and finished off to facilitate occasional transit and patrol by four-wheel drive vehicles for routine pipeline inspection and other equipment maintenance purposes.

Total construction manpower requirements are shown in figure 1.3-8. Construction manpower levels by facility are shown in figure 1.3-9. Estimates of the types of construction personnel necessary and their required work efforts for the respective construction features are presented in table 1.3-2. Material quantities and cost estimates for the different construction features are tabulated in table 1.3-3. The anticipated land requirements for the construction and operation phases of the proposed project are listed in chapter 8.

Port and Onshore Storage Facilities. A west coast shipbuilding yard would construct the prefabricated wharf and service platform with its appurtenances and shore brace trestles. The schedule allows for a minimum of 1 year to make the prefabricated elements available to the construction teams in Skagway.

Concurrently, the port site in Skagway would be prepared and construction would begin along the shoreline from the existing wharf southward to the site. This strip of land would be transformed into an access apron by means of a series of shoreline trestles in conjuction with earthwork shaping along the shore. Neither major earthwork nor significant rock blasting would be anticipated.

After the port facility area became accessible work would begin on the tug berths, mooring points, abutment seats for wharf trestles, and any other structures in the final design. Work could begin on utility services.

TOTAL CONSTRUCTION MANPOWER REQUIREMENTS

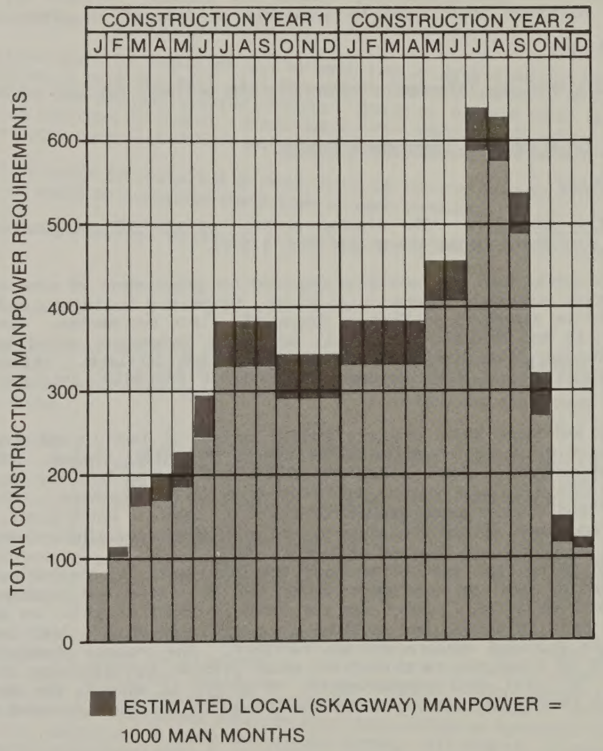


Figure 1.3-8

Source NEC 1979

MAJOR FACILITIES/MANPOWER REQUIREMENT SCHEDULE

Construction Activity Manpower	Construction Year One												Construction Year Two												
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	Total Man-months
Port Facility Manpower Requirement:			20	20	30	40	40	40	40	40	40	40	60	60	60	60	60	60	40	40	40	40	40	20	930
Onshore Storage Facility Manpower Requirement:	60	60	100	100	100	130	150	150	150	150	150	150	170	170	170	170	170	170	170	170	100	100	60	60	3130
Pipeline System, Skagway to Canadian Border Manpower Requirement:							40	40	40								68	88	296	296	296	108			1272
Pump Station AL-1 Manpower Requirement:				10	20	50	50	50	50	50	50	50	50	50	50	50	50	30	20	10					690
Operational Headquarters and Support Facilities Manpower Requirement:		20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	20	20	20	20	20	10	570
Logistical Support Operations Manpower Requirement:	27	34	44	49	53	54	67	67	72	70	70	70	72	72	72	67	72	72	92	91	83	54	33	33	1490[1]
Total Manpower Requirements:	87	114	184	199	223	294	377	377	382	340	340	340	382	382	382	377	450	450	637	627	539	322	153	123	8082

System Operational

Source: NEC 1979

[1] Total includes construction camp personnel

Figure 1.3-9

TABLE 1.3-2

CONSTRUCTION PERSONNEL BY CLASSIFICATION
AND CONSTRUCTION FEATURE 1/

Classification	Marine Terminal Unloading Facility		On-shore Storage Facility		Pipeline System Skagway Boundary		Pump Station to AL-1		Operational Hdqtrs. & Support Facilities		Logistical Support Operations	
	Avg. Mo.	Peak Mo.	Avg. Mo.	Peak Mo.	Avg. Mo.	Peak Mo.	Avg. Mo.	Peak Mo.	Avg. Mo.	Peak Mo.	Avg. Mo.	Peak Mo.
Operating Engineer	3	4	9	12	26	56	1	1	1	2	3	4
Mechanic	1	2	2	3	3	6	3	4	1	2	1	1
Oiler	1	2	3	4	3	7	–	–	1	1	–	–
Dock Builder/ Piledriver	10	12	–	–	–	–	–	–	–	–	–	–
Ironworker	5	7	28	32	–	–	4	5	4	5	–	–
Welder	4	6	36	44	24	50	2	3	2	2	–	–
Electrician	3	5	5	6	5	10	7	8	3	3	–	–
Carpenter	5	7	11	15	–	–	7	8	3	4	–	–
Pipe Fitter/Plumber	5	7	18	22	11	23	9	10	3	4	–	–
Painter	2	3	3	12	5	10	1	3	2	2	–	–
Teamster	1	2	6	8	4	8	1	1	2	2	5	6
Laborer, General	2	3	9	12	28	60	3	3	3	3	4	6
Miscellaneous	–	–	–	–	24	50	3	4	–	–	–	–
Construction Camp Worker	–	–	–	–	–	–	–	–	–	–	30	49
Supervision and Field Office	–	–	–	–	–	–	–	–	–	–	20	30
Totals	42	60	130	170	133	280	41	50	25	30	62 2/	91 2/

Source: NEC, 1979

1/ Average personnel estimates apply only for the period during which respective facilities are being constructed.

2/ Total does not represent sum of personnel classification.

When the prefabricated wharf deck with its associated elements was delivered to Skagway it would be set in place. The large diameter legs would be set on the prepared bottom in accordance with the final design. The platform would be raised on its legs and secured in its final position. The legs would be filled with concrete and the three trestle braces would be set and secured in position.

Then the prefabricated wharf deck appurtenances (loading arms, control house, and other miscellaneous installations and fixtures) would be ready for assembly, bolting, welding, and fixing in place. The piping, equipment, control, and electrical work on the wharf would remain for completion. At this time the shoreline work would be nearly finished.

The installation of the contingency oil spill containment facilities would be completed in the later months of the schedule. The details for these facilities would be developed during final design. The proposed site for the onshore storage facility is presently used by White Pass and Yukon Route for petroleum storage and a pump station for the CANOL line. The existing site is within the area of the Skagway River's 100-year flood plain, so the onshore storage facility would probably be constructed slightly higher than the present ground level. Initially the existing tanks and piping would be removed from the site. Select fill material would be used to raise the existing elevation approximately 3 to 4 feet. The select material would be trucked from the Skagway river mouth deposits and placed in layers and compacted to prevent settlement.

Following the filling and compaction, crews would begin excavating, forming, and placing concrete for tank and building footings and foundations. The concrete would be batched at a central plant in the ore concentrate loading facility area and trucked to the site in transit-mix carriers. Reinforcing rod cutting and bending sheds would be located at the jobsite.

During the fourth month of the schedule the new tanks would begin to arrive in Skagway. These would become available at approximately 1 to 1 1/2 month intervals. Erection would be performed by crews using cranes and arc welding generator sets. Welding would be done in accordance with applicable codes. Radiographic (x-ray) testing of welds would be specified. Construction would take approximately 16 months.

The steel dikes which encircle each tank would be constructed by the crews doing the tank work.

After a tank is erected it would be painted. The type of paint and number of coats would depend on final design specifications and whether or not factory coating of tank plates is selected by the designers.

Yard piping, manifolds, grounding, and miscellaneous items within the immediate tank area would then be installed.

It will take approximately 1 year to fabricate and deliver the 3.5 mile, 42-inch unloading pipe. Pipeline laying would begin at the onshore storage facility and move toward the port. Excavated material would be placed alongside the pipeline trench for later use as backfill. Any surplus or unsuitable materials would be hauled away either to facility sites for use, or to materials sites for accumulation and eventual disposal.

Bending and cutting of pipe would be done at a yard at the ore storage area. All pipe would be trucked to the trench-side for further handling by the pipe-laying equipment crew. Pipe-laying would proceed on a prepared trench bedding. Joints would be welded in the trench and after x-ray inspection, joint coating, backfilling, compaction, and hydrostatic testing, the surface would be restored to conform with surrounding conditions.

Valve pits, cathodic protection, insulation for above-ground portions, and other miscellaneous finishing construction would also be required. Specifications for these would be developed in the final design process.

TABLE 1.3-3 MATERIALS, QUANTITIES AND COSTS $ U.S. 1000

Materials (unit)	Port Facility		Onshore Storage Facility		Pipeline System Skagway to Canadian Border		Pump Station AL-1		Operational Headquarters and Support Facilities		Logistic Support Operations		Totals	
	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Earthwork fill & pipe bedding (1000 cubic yards)		$	400	$ 800	10	$ 20	10	$ 20	10	$ 20		$	430	$ 860
Lumber (1000 board feet)	600	360	50	25	4	2	4	2	5	2	20	8	683	399
Concrete (cubic yard)	5,000	300	5,000	300	100	6	1,100	66	18,001	150	3,000	180	13,000	1,002
Steel plate, bars and shapes (ton)	10,000	9,000	17,000	12,000	—	—	20	18	20	18	—	—	27,040	21,036
Steel pipe 42-inch diameter (foot)	—	—	17,000	1,100	—	—	—	—	—	—	—	—	17,000	1,100
Steel pipe 36-inch diameter (foot)	—	—	—	—	76,000	4,500	—	—	—	—	—	—	76,000	4,500
Yard Pipe Misc. Diameters (ton)	1,000	900	6,000	5,000	—	—	500	500	100	1,000	50	50	7,650	7,450
Miscellaneous metal (ton)	100	120	500	500	—	—	100	120	100	120	10	10	810	870
Fixed equipment and controls (lump sum)	—	2,000	—	2,000	—	—	—	4,000	—	3,000	—	500	—	11,500
Electrical cable, switchgear, panels, etc. (lump sum)	—	500	—	500	—	300	—	200	—	500	—	150	—	2,150
Pre-fabricated buildings (square feet)	6,000	70	—	—	—	—	25,000	275	25,000	275	40,000	500	96,000	1,120
Ship fender system (lot)	1	1,000	—	—	—	—	—	—	—	—	—	—	1	1,000
Totals		$14,250		$22,225		$4,828		$5,201		$5,085		$1,398		$52,987

Source: NEC 1979

Notes:

Earthwork for fill and pipe bedding will be truck transported from the materials site at the ore concentrate terminal to the onshore storage facility site and to the pipeline crews.

All steel items, lumber, miscellaneous metal, yard pipe, equipment, controls, electrical items, prefabricated buildings and ship fender system will be transported from west coast ports to Skagway via cargo vessels or barges, where the materials will either be taken directly to the applicable job site or to one of the materials sites.

Concrete will be batched dry at the materials site at the ore concentrate terminal and mixed in transit by trucks enroute to the various applicable placement locations. Cement will arrive at Skagway by vessel or barge from west coast ports. At Skagway, cement will be stored near the batch plant under covered storage facilities.

Pipeline System. The pipeline construction right-of-way normally would be 90 feet including stretches where the pipeline diverges from the railroad. Fifteen feet would separate the edge of the rail from the centerline of the pipe. Based on a 90-foot construction right-of-way the total surface area disturbed would be about 135 acres. NEC indicates it would re-install the CANOL pipeline in the same trench approximately 1 foot away from NEC's proposed pipeline.

The White Pass and Yukon Route railway out of Skagway would be used exclusively as a materials transportation system and work train for the 14 miles of construction between the Alaska/British Columbia border and the Skagway storage and port facilities. Approximately 10,000 tons of material would be transported from Skagway over the rail line in a 5-month period. Although some railcars might require some minor modifications to carry materials, the system would accommodate the small quantity of traffic on a committed basis. Storage facilities at Skagway, currently totalling over 13 acres, would serve as a storage area for materials. Table 1.3-4 provides quantities and costs of major materials which would be used for construction of the 14 miles of pipeline in Alaska.

TABLE 1.3-4 PIPELINE CONSTRUCTION MATERIALS

Category	Quantity	Unit Price	Cost
Pipe	76,138 ft.	$ 58.97/foot	$4,489,858
External coating	73,920 ft.	$ 4.67/foot	345,206
Valves & controls	6	$ 60,000/each	360,000
Bypass assemblies	1	$954,000/each	954,000
Weights	35	$ 450/each	15,750
Welding rod	17,000	$ 0.80/lb.	13,600
Blasting powder	2,888,000	$ 72.00/100 lb.	2,079,360
		Total cost	$8,257,774

Source: NEC 1979

Since the facilities of the White Pass and Yukon Route railway would be used in a work train operation, limited use would be made of conventional pipeline construction equipment.

Manpower requirements for pipeline construction would peak at approximately 296 workers. They would be transported from the camp site or marshalling yard by bus to the right-of-way and then by rail to the work site.

The 14 miles from Skagway to White Pass would generally require rock construction. Five crews would work independently, progressing at an aggregate rate of 490 lineal feet per day. The mainline crews would work at a rate of approximately 1,000 lineal feet per day.

The entire right-of-way would be cleared as necessary for construction. Clearing would generally be a hand operation and would require the interruption of railway operations. Merchantable timber cleared from the right-of-way would be salvaged and the remainder burned.

Construction would consist of blasting an additional 30 feet of right-of-way adjacent to the existing 15-foot railway bed, giving a new right-of-way width of approximately 45 feet. Due to the extremely steep side slopes it would usually be necessary to pioneer a bench on top of the cut for the grade drills. In some instances where deep cuts are required the grade rock would be taken off in two or more lifts. The grade would be drilled on a 6-foot by 6-foot or 8-foot by 8-foot pattern, depending on the depth of cut, and loaded with a powder factor of approximately 1.5 pounds per cubic yard. The trench would be drilled on a 5-foot "dice 5" pattern and loaded with a powder factor of approximately 3 pounds per cubic yard.

Throughout most of the 14 miles the trench would be blasted to accommodate the 36-inch diameter pipeline and the 4-inch diameter CANOL pipeline, with a 12-inch separation between the two when laid. The trench would be excavated with hydraulic backhoes. NEC has not indicated whether the CANOL line would be replaced using new pipe.

After the trench has been excavated, a 6-inch layer of bedding material would be placed in it to protect the pipeline from external damage. Select bedding and padding material would be obtained from the Skagway River dredging operation and hauled to the work site by ballast cars or dump trucks. The material would be dumped at the work site, then placed in the ditch by a front-end loader and/or side dump and finished by hand. As an alternate source of select bedding material, a crusher could be installed in the vicinity of Skagway, where blasted right-of-way rock could be crushed, hauled to the work site by rail, and placed in the trench for bedding and padding.

After being bent in a work yard near Skagway, the pipe would be hauled to the work site on railway flat cars. The hauled pipe would be lined up in the trench by a crane mounted on a railway flat car, working off the track. Line-up and welding would be done in the trench where each completed weld would be 100 percent x-rayed and wrapped by hand. The pipe would be factory "thin mil" coated.

After the pipe has been welded, x-rayed and lowered onto the bedding, it would be padded by select backfill to a depth of 6 inches over the top of the pipe. The remainder of the ditch would be filled with select ditch excavation material. The ditch and pipeline would be protected from water erosion by the use of ditch breakers.

Cover on the pipeline where it parallels the railroad would be 48 inches deep. Where the pipeline deviates from the railroad, the cover would be 24 inches in solid rock or 30 inches in earth. The minimum depth of burial at creek or river crossings would be at least 48 inches and always below the established scour depth.

After backfilling and clean-up, the pipeline would be pigged with a cleaning pig and a gauging pig to remove any debris in the line and to ensure that there is no pipe deformity.

The pipeline would then be hydrostatically tested for 24 hours at a constant pressure. If any defects appear during the test the affected area would be replaced and the test repeated until a successful test has been achieved.

The Skagway River would be used as the water source for hydrostatic testing. The test water would be drawn from the river during high or moderate water level periods. The water would be filtered at the intake to ensure its cleanliness. Due to severe static head conditions, it would be necessary to test the 14 miles of pipeline in short sections. This would necessitate a water transfer operation from section to section by means of high pressure fill and booster pumps. Pressurization of the pipeline would be done with a hydrostatic pump capable of pressurizing at a constant measured input. After completion of the hydrostatic test, the water would be filtered of impurities and discharged into one of the numerous rivers or streams at the Alaska/British Columbia border in the vicinity of the pipeline as agreed upon by the authorizing agencies.

After testing, the sections would be tied in to form a continuous line. All tie-in welds would be x-rayed and hand wrapped and the tie-in points cleaned up.

Main Line Stations and Delivery Facilities. The pump station would be integrated with the onshore storage facility. Site preparation and construction of foundations would be carried out by the storage tank crews. Including the booster pump facilities, there would be four pump buildings, each about 2,000 square feet. The metering and proving house would lie between two pairs of pump houses.

The buildings would be designed as arctic or sub-arctic type, selected on the basis of snow loads, insulation properties, exterior finish coating, and the higher ranges of wind pressures. The construction schedule allows 3 to 4 weeks for completion. The buildings would be factory coated. The pump, metering, and other equipment would not be on the jobsite until well into the second construction year.

NEC has not furnished any information concerning construction of delivery facilities at Keg River, Alberta, Canada.

Operation Phase

The Skagway control center would have the primary responsibility for operation of the proposed pipeline system. Backup control would be provided at Fort Nelson, British Columbia. Each operations and maintenance area would have facilities, personnel, and equipment to operate and maintain a specific section of the pipeline. The Skagway area office would operate and maintain the facilities in Alaska.

Approximate personnel requirements in Alaska are:

Operations head office and onshore storage facility	30
Marine terminal facility	14
Pump station	5
Technical maintenance center	20
Materials supply depot	5
Total	74

The railway and/or conventional tracked equipment would be used in major overhaul and repair operations in Alaska. Equipment used would include tracked side-boom pipelayers, bulldozers, track-mounted backhoes, and draglines.

Fixed-wing aircraft would be the usual mode of transportation for line patrols and long distance travel. Helicopters would be used to locations that are otherwise inaccessible.

Servicing of support systems would be performed by maintenance personnel. Predictive and preventive maintenance programs would be developed to schedule inspection and repairs of equipment and controls at regular intervals before deterioration of any individual unit resulted in an unscheduled shutdown.

The stations would be provided with the safety shutdowns and control equipment. A control room would house local control and sequencing equipment, instrumentation read-outs, status indicators, and alarms for all equipment. The station could be operated from the control room in case of interruption or malfunction in the remote control system or communications link.

Each station would be provided with two generators to generate the electric power required. Normally one generator would be in use and the other on standby, with automatic change-over in case of a shutdown of the operating unit. A storage battery would be installed to provide a "no break" supply for the control and communications systems as well as for emergency lighting. Generating equipment and switchgear would be housed in the station services building which would also contain the workshop, control room, and office. Emergency crew quarters would be provided to house maintenance personnel during periods of inclement weather.

Abandonment Phase

Upon termination of the proposed project, NEC would remove all oil receiving facilities at the port. The wharf and any requested equipment would remain. The unloading line would be filled with an inert material such as nitrogen, sealed, and left buried. All aboveground appurtenances would be removed.

Tanks and support facilities at the onshore storage site for which other uses have not been designated would be dismantled, and salvaged when feasible. NEC plans that the pipeline to the Canadian border would be filled with inert material (nitrogen or glycerin), sealed, and left buried. All above-ground structures would be removed.

Cost Estimates

Construction Costs

NEC projects the capital costs of the port facility and onshore storage facilities at Skagway and pipelines to the Alaska/British Columbia border at 219 million U.S. dollars. The capital costs of pipeline facilities from the Alaska/British Columbia border to Keg River, Alberta, would be 700 million U.S. dollars (see table 1.3-5 for cost estimate summary).

TABLE 1.3-5 PROJECT COST ESTIMATE SUMMARY
($U.S. Million 1978)

Cost Category	U.S. Segment	Canadian Segment	Total
Land	1.0	4.5	5.5
Pipeline	39.3	381.2	420.5
Pump stations	15.0	74.6	89.6
Support facilities	1.9	71.6	73.5
O & M facilities	6.5	14.4	20.9
Onshore storage facility	76.1	-	76.1
Port facility	28.5	-	28.5
Communications	3.6	9.8	13.4
Sub-total direct cost	171.9	556.1	728.0
Engineering management	5.6	22.2	27.8
Contingency	8.6	27.8	36.4
Allowance for funds used during construction	32.9	93.9	126.8
Total	219.0	700.0	919.0

Source: NEC 1979

Annual Operating Costs

Table 1.3-6 shows NEC's estimate of annual operating costs.

TABLE 1.3-6 ANNUAL OPERATING COST
($U.S. MILLION 1978)

	U.S. Segment	Canadian Segment	Total
Operation & Maintenance	$ 4.4	$10.6	$15.
Fuel	3.6	12.6	16.2
Property Tax	2.1	6.1	8.2
Total	10.1	29.3	$39.4

Source: NEC 1979

The 10-year average tariff for the section from Skagway, Alaska to Keg River, Alberta, using 18 percent return on equity and 11 percent interest on long term debt, would be $1.03 per barrel (U.S.). NEC has not provided tariff information from Keg River to northern tier states.

NEC states the tariff is based on a cost of service principle and consists of operation and maintenance expenses, depreciation, taxes, and return on the rate base. The depreciation is based on a 25-year life of the facilities. The rate of return on the rate base is a composite rate and is based on the capitalization structure. For a case in which capital structure is 75 percent debt and 25 percent equity the composite rate would be 12.8 percent.

Transportation Costs

Transportation cost summary from Skagway, Alaska, to Keg River, is given in table 1.3-7.

TABLE 1.3-7 TRANSPORTATION COST SUMMARY
$ U.S./Barrel 1978

Year	U.S. Section	Canadian Section	Total
1	.30	.93	1.23
2	.27	.87	1.14
3	.25	.83	1.08
4	.24	.83	1.07
5	.22	.81	1.03
6	.21	.79	1.00
7	.20	.77	0.97
8	.19	.76	0.95
9	.18	.74	0.92
10	.17	.73	0.90
10 year avg.	.22	.81	1.03

Source: NEC 1979

Abandonment Costs

Estimates have not been made of the expense required to abandon the proposed system. Such expenses are included in the Interstate Commerce Commission rate method, but were not included by Department of Energy in their tariff estimates. If a dismantling fund is required it would add to the transportation costs. In the case of the Trans Alaska Pipeline System this charge in the tariff is 9.6 cents per barrel.

Net Energy Balance

Table 1.3-8 summarizes NEC's estimate of the net energy balance of the proposed oil transportation system.

Tables 1.3-9 through 1.3-13 indicate NEC's estimates of energy delivered and energy consumed. The calculations embody all energy that would be used to transport oil from Valdez and offshore to Keg River with the exception of main line pumping energy which was calculated only from Skagway to Keg River.

TABLE 1.3-8 NET ENERGY BALANCE SUMMARY
(20-year project life)

	Energy Equivalent (Million BTUs)
Crude petroleum delivered1/	20,553,953,000
Energy consumption	
Tanker fuel2/	287,072,387
Main line liquid fuel pumping3/	148,943,323
Construction materials4/	28,049,776
Other5/	8,233,135
Total consumption	472,298,621
Net energy delivered	20,081,654,379

Source: NEC 1979
1/ See table 1.3-9 for derivation.
2/ See table 1.3-10 for derivation.
3/ See table 1.3-11 for derivation.
4/ See table 1.3-12 for derivation.
5/ See table 1.3-13 for derivation.

TABLE 1.3-9 CRUDE PETROLEUM DELIVERED

Crude Oil Type	Approx. Percent of Throughput Volume	Volume Delivered 20 Years (Million bbl)	Net Heat Content (Thousand BTUs/bbl)	Energy Equivalent 20 Years (Million BTUs)
Alaskan north slope	80	2920	5675.5	16,572,460,000
Foreign	20	730	5454.1	3,981,493,000
Total	100	3650		20,553,953,000

Source: NEC 1979

TABLE 1.3-10 ENERGY CONSUMPTION--TANKER FUEL 1/

Throughput (bpd)	Oil Source	Average Tanker Size (dwt)	Bunker Consumption (tons/year)	(bbl/year)	Energy Equivalent 20 Years (Million BTUs)
400,000	Valdez	120,000	121,271	812,516	125,176,377
100,000	Foreign	225,000	156,845	1,050,862	161,896,010
Total					287,072,387

Source: NEC 1979
1/ Based on round trip consumption for 120,000 dead weight ton tankers from Valdez to Skagway (Jones Act tankers) and 225,000 dead weight ton tankers from offshore sources to Skagway.

TABLE 1.3-11 ENERGY CONSUMPTION--MAIN LINE FUEL FOR PUMPING CRUDE OIL

Annual Energy Consumption (Million BTUs)	Total Direct Energy Consumption 20 Years (Million BTUs)	Primary Energy Coefficient	Energy Equivalent (20 Year) (Million BTUs)
6,090,755	121,815,100	1.2227	148,943,323

Source: NEC 1979

TABLE 1.3-12 ENERGY CONSUMPTION--CONSTRUCTION MATERIALS

Category	Quantity (tons)	Primary Energy Coefficient	Equivalent 20 Years (Million BTUs)
Pipe	233,750.5	111.0	25,946,306
Tank steel	16,236.0	111.0	1,802,196
Other			301,254
Total			28,049,776

Source: NEC 1979

TABLE 1.3-13 ENERGY CONSUMPTION - OTHER

	Energy Equivalent 20 Years (Million BTUs)
Power requirements for port facility	6,427,233
Fuel used during construction	1,700,013
Pump and motor units	95,904
Fuel for emergency generators	9,985
Total	8,233,135

Source: NEC 1979

Detailed estimates have not been made by NEC of the energy consumed in production of construction materials (other than pipe and tank steel) or the fuel required for construction, emergency generators, or the port facility. These energy requirements were estimated by NEC based on calculations which were done with respect to the Northern Tier Pipeline Company proposal. They appear in Appendix G of Volume 2 of the U.S. Department of Energy's draft report "Petroleum Supply Alternatives for the Northern Tier and Inland States Through the Year 2000" of February 21, 1979. The total of these uncertain areas represents about 2 percent of the total energy requirement or 0.04 percent of the gross energy delivered.

Contingency Plans

A set of oil spill contingency plans for each part of the proposed pipeline system would be prepared before operation begins. Contingency plans would be prepared for: (1) the 14-mile segment of pipeline; (2) the onshore storage facility; (3) the port facility; and (4) the proposed tanker route along Chatham Strait and Lynn Canal. These contingency plans would be integrated into one document so that spill response operations would function systematically. Prior to construction NEC would also prepare preliminary contingency plans in case of potential spills from supply vessels and onshore construction vehicles.

A series of background studies would be undertaken to provide baseline data for the operational contingency plans, including environmental baseline conditions, oil elements, spill and response technology, reclamation studies, staffing and personnel requirements, and synthesis studies. Background studies would begin shortly after the major permits were received.

Upon completion of the studies NEC would develop procedures for responding to spills occurring during operations. These would consist of a response plan which describes what to do in the event of a spill, with sections which would include detailed operating instructions, constraints, technical performance data, and manpower skills required to carry out actions specified in the response plan. Training of personnel charged with implementing the contingency plans would begin after a working draft had been written.

The contingency plans would be field tested prior to startup of the facility. Personnel would respond to simulated spills, some requiring full scale implementation of response equipment and staff. At least one spill from an offshore tanker and one spill from an onshore pipeline would be simulated during the field drills. Lessons learned from these exercises would be incorporated into revised contingency plans. Final decisions concerning what spill response equipment to acquire would be made upon completion of these exercises.

Following the field drills, the contingency plans would be submitted to the appropriate government agencies for approval. Contingency plans developed pursuant to the right-of-way agreement would be submitted for federal agency approval. Prior to operation, the operations manual for the port facility, the spill prevention control and countermeasure plan for the onshore storage facility, and the emergency response plan for the pipeline would be submitted to the U.S. Coast Guard, the Environmental Protection Agency, and the Office of Pipeline Safety. The plans would also be submitted to the Alaska State Department of Environmental Conservation for approval.

As new information became available on spill cleanup technologies, restoration practices, and training practices, it would be incorporated into the plans. Major changes in the plans would be submitted for review by the appropriate public agency.

Concurrently with the development of operational contingency plans, NEC would prepare preliminary contingency plans which would address detection, notification, evaluation and initiation of action, containment, cleanup, disposal, restoration, and documentation. It would establish a spill response team and provide for the requisition and siting of containment and cleanup equipment.

The operational contingency plans would describe the location, capability, and limitations of available pollution response equipment. During development of the plans NEC would decide what equipment to purchase including equipment for cleaning up spills in marine waters. NEC would buy booms and skimmers which are built for open ocean recovery, capable of operating effectively in seas of 5 feet and currents up to 2 knots.

Enough equipment would be maintained by NEC to clean up most spills occurring from the pipeline system. If a catastrophic spill (i.e., a large tanker spill of 500,000 barrels) were to occur, outside help would be required. The contingency plans would establish mutual aid agreements between NEC and other west coast spill cooperatives, contractors, and salvage companies located in Cook Inlet, Valdez, Puget Sound, and San Francisco. The response time in that case would be about 24 hours. NEC could also seek assistance from the U.S. Coast Guard Pacific Strike Team which has a variety of containment and cleanup gear.

An ocean skimmer, heavy duty boom, sorbents and dispersants, boats, and oil containers would be stockpiled at storage sites along the tanker route or at Skagway and Juneau. Equipment stored at the port and onshore storage facilities would include earth moving equipment, vacuum tank trucks, high capacity pumps, and lighter booms and skimmer equipment. Specific equipment decisions would be made in coordination with the Coast Guard's Arctic Pollution Response Program.

The contingency plans would include a variety of other equipment to be used in responding to oil spillage including communications gear, cold weather clothing, trucks, hand tools, food, sanitation support services, and lighting for night work. The plans would designate sites suitable for use as on-scene command centers which would serve as headquarters during containment and cleanup operations. Aircraft support would be available for use during reconnaissance and cleanup operations.

Directions detailing the proper use of cleanup equipment would be provided in the contingency plans for specific locations along the tanker route, Skagway harbor area, and pipeline route. These would include instructions on how and where to set booming equipment and how to pick up spilled oil and the capabilities of available equipment to operate effectively under different sea and weather conditions. The contingency plans would also contain information on where spilled crude oil would flow both onshore and offshore.

The contingency plans would identify vulnerable resources and rank them on a priority basis for protection. Examples of such vulnerable resources would be (1) endangered species habitat, (2) water supply intakes, (3) fish rearing sites, (4) parks and recreation areas, (5) wildlife refuges, and (6) marine mammal haul out areas. This information and the spill trajectory data would be combined into an environmental atlas for use on-site during response operations. The atlas would also contain information on proper methods for cleaning up environments such as rocky beaches, wetlands, and tundra.

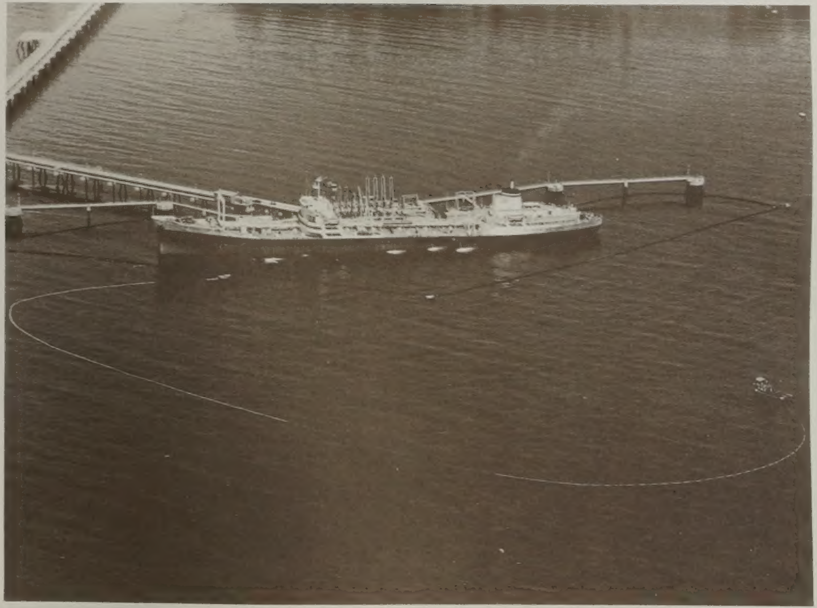
Disposal of spilled oil can pose substantial cleanup problems in cold weather. Methods of disposing of oil include burning, burial, natural biodegradation, and oil/water separation with return of spilled oil back to the pipeline system. The plans would also identify suitable disposal sites.

The plans would examine methods for restoring resources damaged by spilled oil. They would address specific cultivating, fertilizing, seeding, transplanting, and mulching techniques for each of the major habitats potentially affected by a spill: wetlands, rocky intertidal, coastal meadows, riparian vegetation, forests, and alpine tundra.

The contingency plan would also address security procedures for protecting the pipeline, onshore storage facility, and port facility from vandalism and unauthorized entry. Security guards would be stationed at the port and onshore storage facilities to conduct both regular and random patrols. Adequate lighting and intruder detection systems would also be installed and authorized personnel would be issued identification cards. The onshore storage and port facilities would be fully fenced with locking entrance gates.

The Fire Protection Coordinator (FPC) would prepare contingency plans to combat fire and explosion accidents and to direct emergency operations. The FPC would develop detailed action plans which would address control of different sizes and types of fires. Emergency evacuation plans which would include provisions for rapidly removing a stricken vessel from the pier area would be prepared by the FPC. The Fire Protection Coordinator would be in charge of training personnel in fire fighting and first aid procedures and conducting inspections to check compliance with fire codes and prevention practices.

Contingency plans prepared by the Fire Protection Coordinator would specify what fire protection equipment should be kept on-site. At a minimum the plans would provide for protective clothing, self-contained breathing apparatus, stationing of a fire truck near the onshore storage facilities and pumping station, and fitting of tugs at the port facility with fire fighting equipment.



Booming a crude oil tanker

Bureau of Land Management

NEC's contingency plans would also provide for the treatment of people injured by fires or explosions. The plans would specify on-scene first aid procedures and methods for transporting casualties.

The contingency plans would call for thorough documentation of the circumstances and handling of each spill or accident as soon after the emergency as possible. This information would be forwarded promptly to appropriate state and federal agencies. The Documentation Coordinator would also review case studies of spills occurring at other similar facilities. The plans would set forth actions to be taken after documentation of the spill, including the retraining of personnel, the acquisition of additional equipment, and the revision of company contingency policies and procedures.

Specific measures proposed by NEC to protect the environment are:

1) Three tugs would be equipped with firefighting capability and a trained crew.

2) Two fire trucks would be provided as a part of the fire protection system for the onshore storage facility.

3) All storage/surge tanks would be painted with colors to blend with the surroundings, and the onshore storage and port facilities would be landscaped.

4) The construction management team would include an environmental inspector for the pipeline and onshore storage and port facilities.

5) Restoration of disturbed areas would emphasize grading sites to harmonize with existing contours, reseeding with native vegetation, re-establishment of original drainage patterns (where possible), and erosion control.

6) All main line valve sites in open areas would be landscaped to blend with the surroundings.

7) Dust producing areas would be watered during construction in Skagway to minimize dust emissions.

8) If blasting is required during construction, mats would be used to limit the "throw" of loosened materials.

9) Where extensive grading is required, and until revegetation is established, runoff would be trapped and sediments would be removed prior to release to natural water courses.

10) Stream hydraulics and geotechnical information would be established for each stream and river crossing, and the depth of burial of the pipeline at these crossings would be established to insure that the pipeline would not be subject to exposure by stream scour.

11) NEC would sponsor training seminars for the management of oil spills, fire, and explosion accidents and also improve the effectiveness of response measures when spills occur.

12) Flood debris would be cleared from the right-of-way across streams.

13) When excavating the pipeline trench, NEC would remove and store the surface mat topsoil and underlying parent materials separately and replace them in the original sequence after the pipeline has been buried.

1.4 Proposal of Kitimat Pipe Line Ltd.

Kitimat Pipe Line Ltd. (KPL) filed an application on December 8, 1978, before the Secretary of the Interior for consideration under Title V of the Public Utility Regulatory Policies Act of 1978 (Public Law 95-617). The KPL proposal is based on an application originally presented to the Canadian Energy Board in 1976. The proposal involves construction and operation of a common carrier crude oil transportation system entirely within the national borders of Canada, connecting with existing pipeline systems serving the northern tier and inland states.

Because the proposal involves activities that would impact lands and waters which lie entirely within a foreign country, Executive Order 12114 (EO 12114), Environmental Effects Abroad of Major Federal Actions, applies. EO 12114, as interpreted by the Department of the Interior in consultation with the Council on Environmental Quality, limits the need for impact analysis on the KPL proposal. Consequently, the description of the proposal in this chapter, as well as discussion in chapter 8, will be abbreviated.

KPL's proposal is currently being held in abeyance by the Canadian National Energy Board and has been the subject of significant study since it was initially proposed in 1976.

Sea Leg

KPL proposes to build a port near Kitimat, British Columbia. Kitimat is located on the fiord Kitimat Arm, at the northern end of Douglas Channel.

It is proposed that tankers up to 320,000 dead weight ton would deliver crude oil from Alaskan and foreign sources. Ships would approach Douglas Channel and Kitimat through Dixon Entrance from the open sea. At Dixon Entrance, two licensed pilots would take tankers through Browning Entrance, Principe Channel, Nepean Sound, Otter Channel, Squally Channel, Lewis Passage, and Wright Sound, into Douglas Channel.

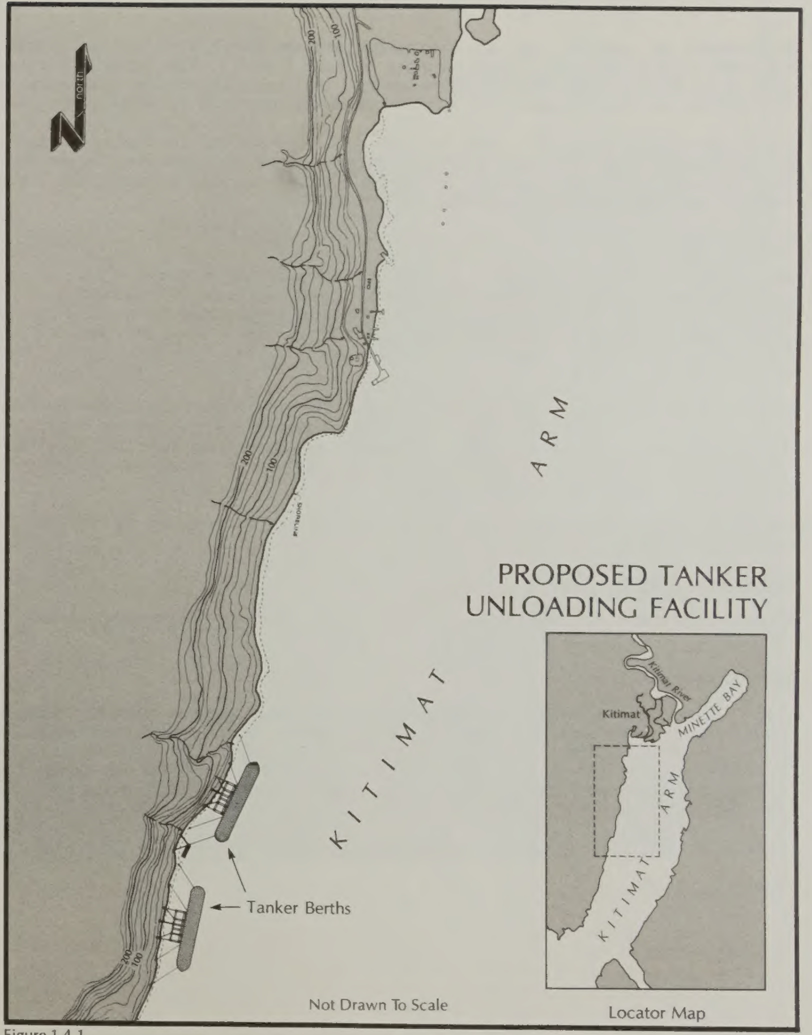
The total distance from the open sea to the proposed port would be approximately 881 nautical miles. Initially KPL estimates seven tanker port calls per month, increasing to approximately 13 per month.

Port and Onshore Storage Facilities

Tanker Unloading Facilities

KPL proposes to construct and operate a port near Kitimat, British Columbia, approximately 500 miles north of Vancouver, British Columbia. The port would be about 6.5 miles southwest of Kitimat on the west coast of the fiord Kitimat Arm.

The port would consist of two floating docks, each capable of handling vessels up to 320,000 dead weight ton. Each floating dock would be a tubular, semisubmersible structure, 420 feet long, 125 feet wide, 25 feet deep, with a draft of 10.6 feet, anchored to two shore anchors. Ball joints would permit fluctuation, wave action, and motion resulting from ship forces (see figure 1.4-1.)



PROPOSED TANKER UNLOADING FACILITY

Figure 1.4-1

Onshore Storage Facilities

KPL proposes to construct and operate onshore storage facilities "at some distance from town" with an initial storage capacity of from 3 to 5 million barrels. Storage would be in five to nine, 600,000 barrel tanks. All tanks would have cone roofs and cone bottoms and be equipped with internal floating decks to minimize vapor loss.

Storage facilities would be connected with tanker unloading facilities through a 48-inch transfer line, allowing a maximum unloading rate of 80,000 barrels per hour. Power for unloading the crude oil would be provided by ship's pumps. A second transfer line would be installed later, if necessary.

Pipeline System

KPL proposes to construct a 753 mile long, 36-inch pipeline from the onshore storage facilities near Kitimat to Edmonton, Alberta, Canada, as shown in figure 1.4-2. At Edmonton, the crude oil would be transferred to the Interprovincial Pipe Line Limited System (Interprovincial). Interprovincial extends from Edmonton to Montreal and also branches into Minnesota, Wisconsin, Illinois, Michigan, Indiana, Ohio, Pennsylvania, and New York.

The KPL system is designed for an initial throughput of 450,000 barrels per day with an ultimate capacity of 900,000 barrels per day. Interprovincial has the capability of transporting 1.5 million barrels per day from Edmonton to Superior, Wisconsin. Currently 1.05 million barrels per day of the capacity is being used, leaving an unused capacity of 450,000 barrels per day.

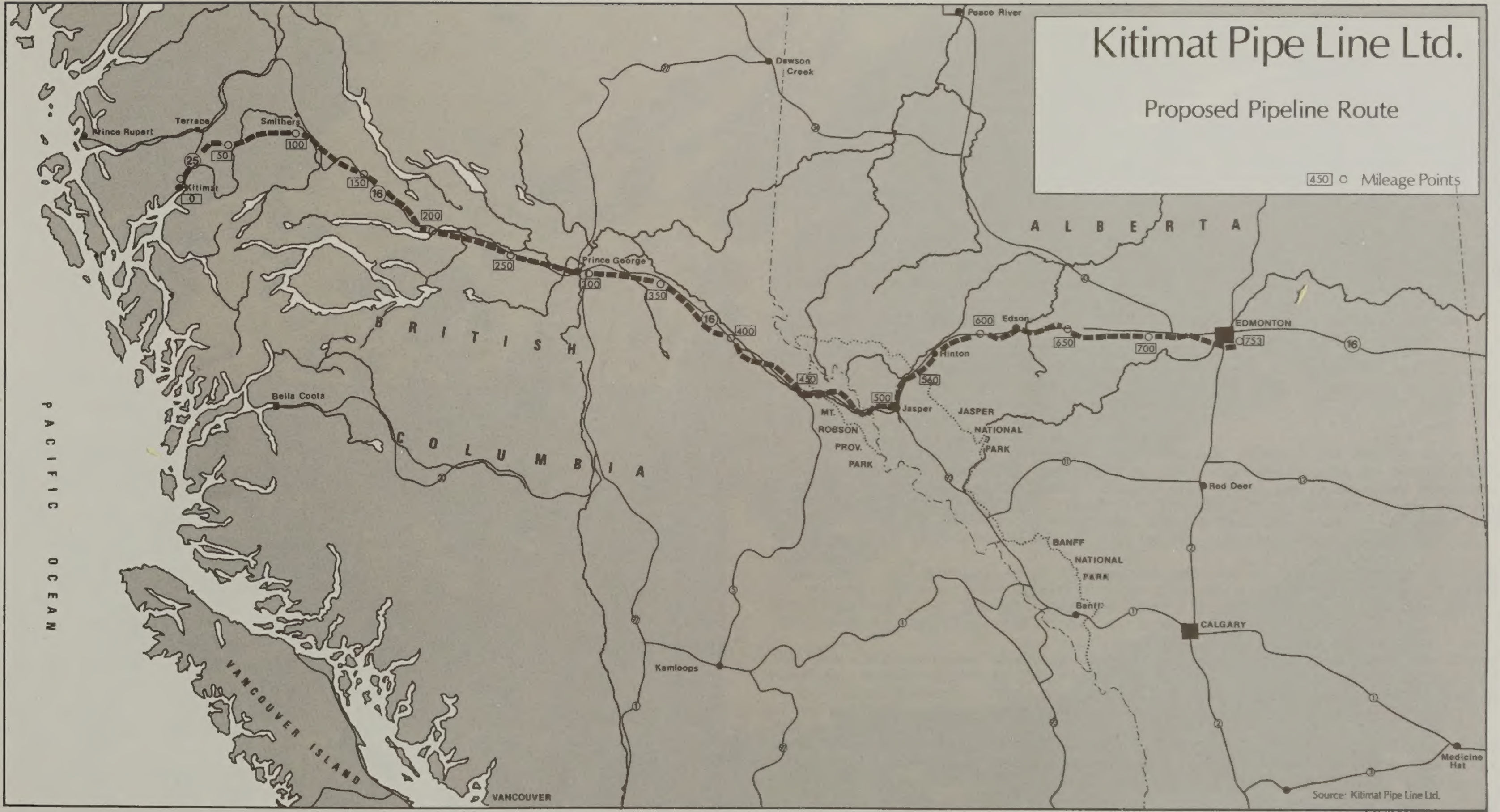
KPL would require 10 pump stations for initial throughput and 16 pump stations for ultimate throughput.

Construction Cost and Time

KPL estimates construction could be completed within two years of project approval at a cost of $750 million Canadian (1977).

Canadian Approvals

Within Canada, KPL is subject to two major regulatory groups, the Termpol Committee (TERMPOL) and the National Energy Board (NEB). TERMPOL is responsible for assessment of the marine components of the proposal. NEB is responsible for reviewing the facilities proposed for the terrestial environment. TERMPOL and NEB would report on the technical aspects of the proposal to the Canadian cabinent, which makes the final determination as to certification.



Source: Kitimat Pipe Line Ltd.

Figure 1.4-2

Not Drawn To Scale

Trans Mountain Oil Pipe Line Corporation Route in Washington State

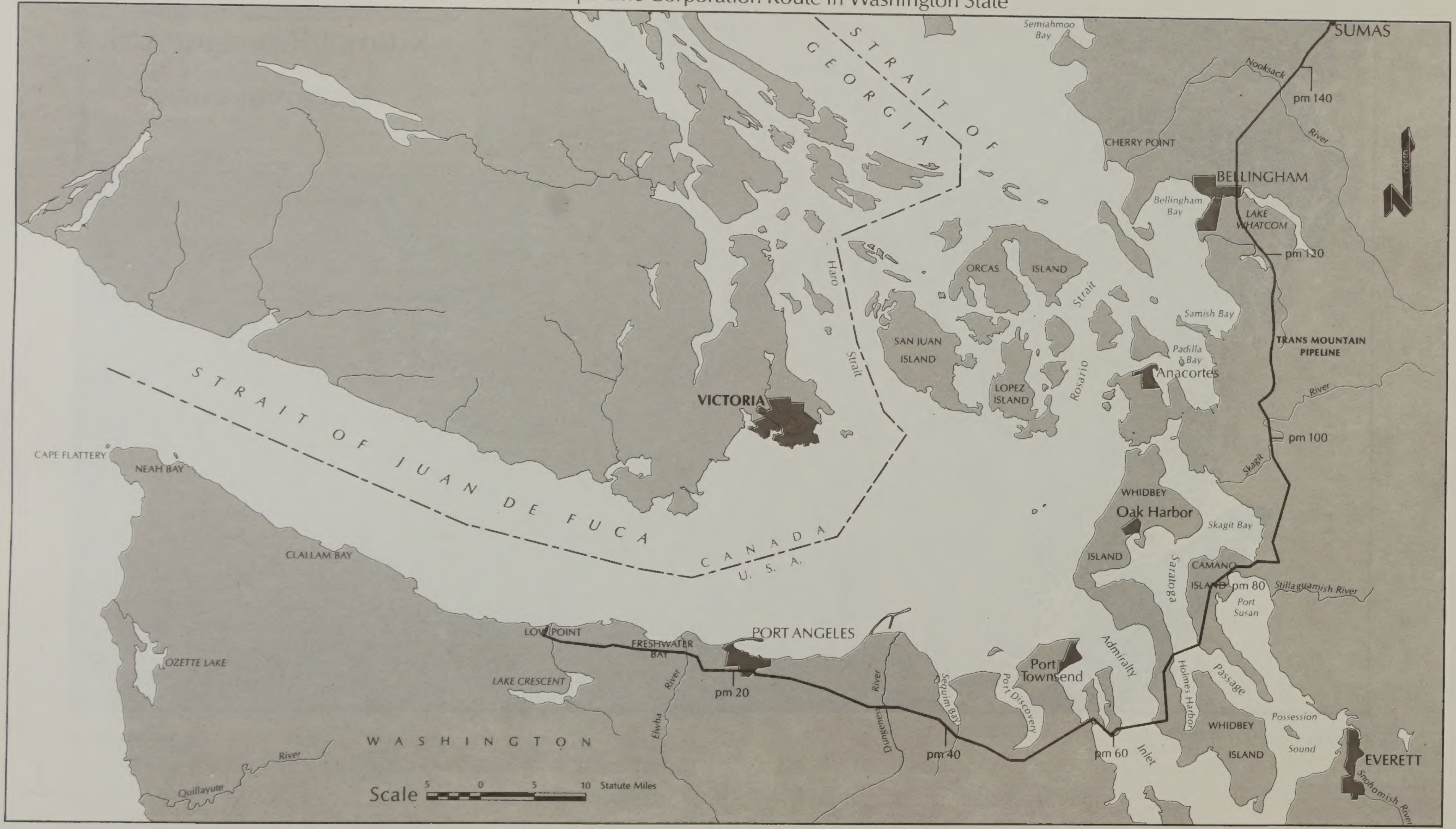
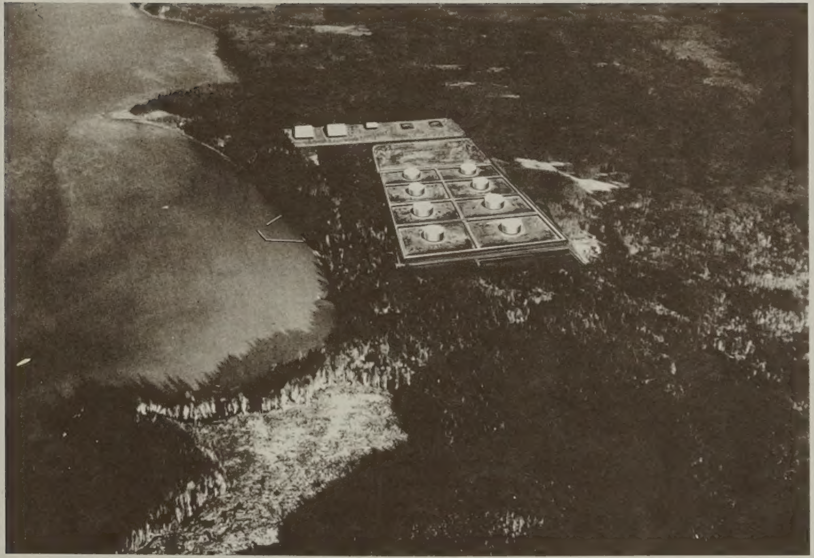


Figure 1.5-4

1.5 Proposal of Trans Mountain Oil Pipe Line Corporation



Proposed onshore storage facilities at Low Point looking east toward Low Point

Source: Trans Mountain Oil Pipe Line Corporation

The Trans Mountain Oil Pipe Line Corporation (TMC), and its Canadian affiliate, Trans Mountain Oil Pipe Line Company Ltd., filed an application on February 6, 1979, with the Department of the Interior to construct a common carrier crude oil transportation system extending approximately 823 miles from Low Point, Washington to Edmonton, Alberta, Canada. Of this, 102 miles is already constructed in Canada. There would be 148 miles required within the state of Washington (see figure 1.5-1); 94 miles would be on new right-of-way. Through connection to existing pipelines in Canada which extend into the United States, the system would be capable of delivering crude oil to refineries in the Rocky Mountain, upper midwest, and eastern states.

In Washington, the proposed crude oil transportation system would include a port facility at Low Point on the north coast of the Olympic Peninsula, approximately 18 miles west of Port Angeles, and a pipeline to Sumas, on the Canadian border. The port would consist of tanker unloading facilities, two submarine pipelines, and an onshore storage facility capable of storing 4 million barrels of crude oil for delivery to the pipeline system.

In the United States the pipeline system would consist of 54 miles of new 30-inch pipeline laid in existing right-of-way owned by TMC, and 94 miles laid in new right-of-way, with mainline valves, three pump stations, and a communications system. A pipeline corridor 2 miles wide and approximately 100 miles long is under study for this purpose.

The proposal would provide two single point moorings (SPM) in 120 feet of water at Low Point for simultaneous unloading of two crude oil tankers. The SPM design would limit the maximum tanker size to the 200,000 dead weight ton class. Two submarine pipelines would carry the oil 2.5 miles from the SPM's to a 300-acre onshore storage facility at Low Point. Included in the onshore facility would be equipment for receiving incoming oil and delivery to the initial pipeline pump station.

As proposed, the pipeline would transport an average of 500,000 barrels of crude oil per day. The ultimate capacity of the pipeline would be approximately 630,000 barrels per day. If initial demand were less than 500,000 barrels per day, horsepower reductions would be made at the pump stations.

From the Canadian-United States border, crude oil would be carried by the Trans Mountain Canadian system to Edmonton, Alberta. A right-of-way already exists for this 675 mile distance. There are 102 miles of 30-inch pipe now in place; 573 miles of new pipeline would be constructed.

The port facility would be fully manned and operated locally. Main line stations along the pipeline route would be designed for control and operation from a centralized location.

Deliveries of offshore oil to Interprovincial Pipe Line Ltd., Edmonton, would enable that company to utilize spare capacity of its system to supply adequate volumes to American refineries. The Interprovincial Lakehead system is capable of transporting approximately 1.466 million barrels per day eastward from Edmonton (see figure 1.5-2). After satisfying Canadian demand west of the Ottawa Valley, plus a portion of the Montreal market, additional capacity remains for transporting crude oil from the TMC system to refining centers in the United States.

Pipeline Network in Canada and Northern U.S.

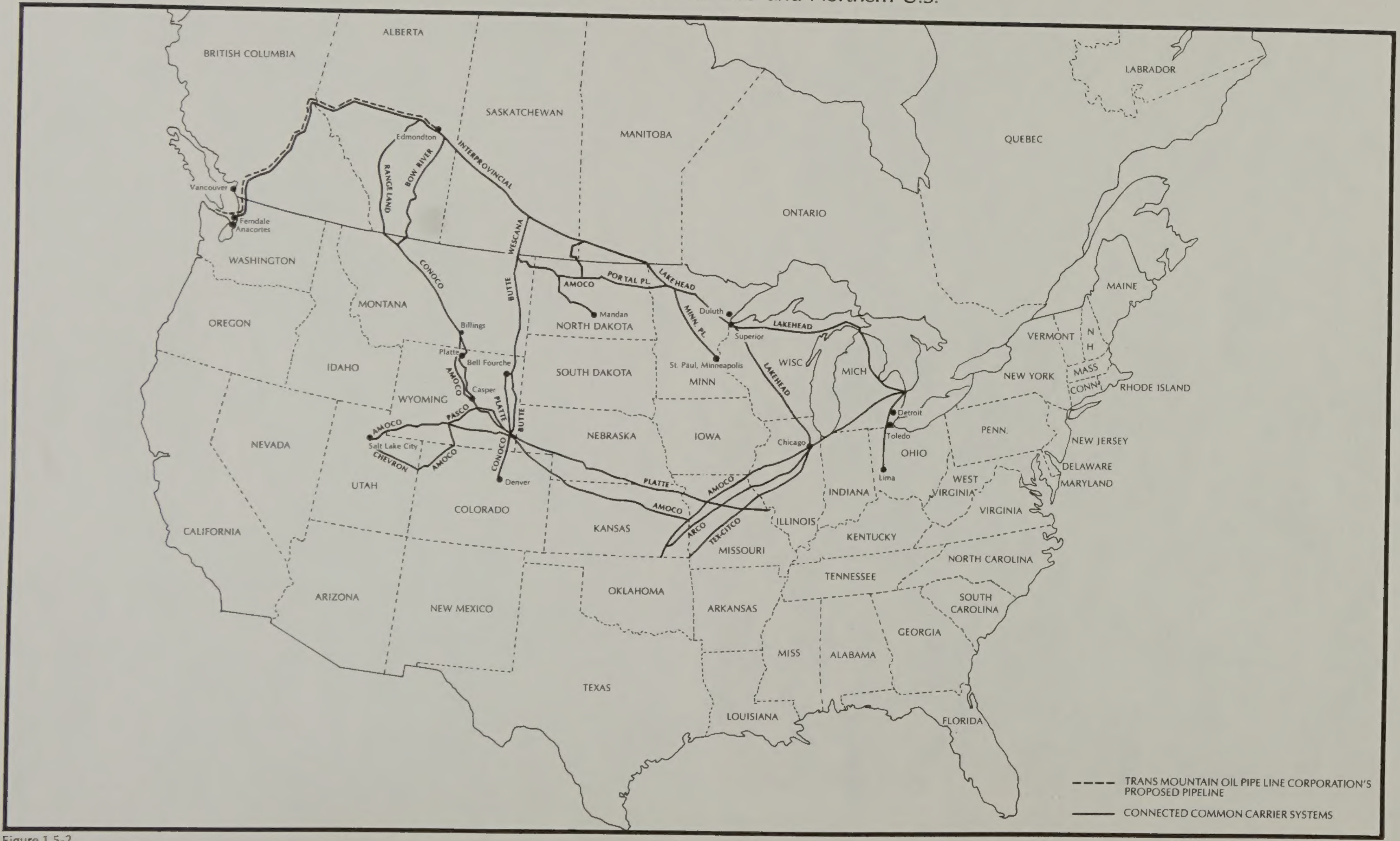


Figure 1.5-2

Deliveries by TMC to Edmonton would enable the Rangeland Pipe Line (Rangeland) system to deliver offshore crude oil to Montana, and through connecting carriers, into other pipelines serving the Rocky Mountain and mid-continent regions of the United States. The Rangeland system has the capability to serve this area, particularly Montana, either from central Alberta supplies made available through exchanges for crude oil delivered by the TMC system to Edmonton, or by means of a direct interconnection with the TMC pipeline. This interconnection could be effected by extending the Rangeland system from a location near Sundre, Alberta, to tie in with the TMC pipeline either at Edson or Edmonton (see figure 1.5-2). TMC does not propose to make this connection.

Supplemental deliveries of offshore crude oil to Montana and the Rocky Mountain areas can be made through the Wescana Pipeline system which joins the Interprovincial line at Regina, Saskatchewan, and then is linked to the Butte Pipe Line system in eastern Montana and Wyoming. The Butte and Wescana lines, in turn, connect with the Portal Pipeline in northeastern Montana, and through it link up with the Lakehead system at Clearbrook, Minnesota.

The connecting pipelines shown in figure 1.5-2, together with the proposed facilities, provide a means of allowing transportation of offshore crude from port facilities on the west coast to the northern United States. Due to the phasing out of Canadian oil exports, the connecting pipelines beyond Edmonton are under-utilized, so that supplying offshore crude oil to refining centers in Canada and the United States would not require additional facilities.

Throughput Forecast

Total pipeline volume potential can be considered in two segments. The first is for northern tier refineries currently processing Canadian crude oil and whose access to alternative supplies is limited. The second segment is the volume for those upper mid-west refineries with access to the Lakehead Pipeline system who would choose to process Alaskan north slope crude oil supplied via the TMC system. The potential volume for the pipeline is shown in table 1.5-1. This table results from a review by TMC of available industry sources to forecast demand resulting from shortfalls experienced by the refineries in the north central United States.

Requirements for landlocked refineries in Minnesota, Wisconsin, and North Dakota are 80,000 to 100,000 barrels per day of light, sweet crude, and up to 200,000 barrels per day of heavy crude. Illinois, Indiana, and Kentucky refineries are currently processing about 2.6 million barrels per day. The bulk of this oil is brought by pipeline from the Gulf of Mexico. The proposal of TMC would supply the full requirement of the north central refineries, and a portion of the eastern market (see table 1.5-2).

Currently this shortfall is supplied by Canadian crude oil plus pipeline and barge shipments from the Gulf of Mexico. It is assumed that these would cease once the TMC pipeline was in operation. The sweet crude oil requirement represents less than half of this total shortfall.

TMC would supply Alaskan north slope type crude oil to refineries in states listed in table 1.5-1 and to those refineries further east which have a capability of processing this type of crude as listed in table 1.5-2.

TABLE 1.5-1 PROCESSING POTENTIAL - NORTHERN TIER REFINERIES
(Thousand Barrels per Day)

	1980	1985
Montana		
Crude runs	125	130
Less domestic supply	-65	-70
Shortfall	60	60
North Dakota		
Crude runs	35	40
Less domestic supply	-30	-30
Shortfall	5	10
Minnesota/Wisconsin		
Crude runs	230	265
Less domestic supply	-25	-25
Less foreign sweet - Gulf Coast	-20	-20
Less foreign sour - Gulf Coast	-20	-20
Shortfall	165	200
Total Shortfall	230	270

Source: TMC 1979

TABLE 1.5-2 UTILIZATION OF ALASKAN NORTH SLOPE (ANS) PRODUCTION

	Refining Capacity Barrels per Day Alaskan North Slope Crude Oil		
	Low		High
Illinois	80	-	115
Indiana	80	-	80
Ohio	45	-	65
New York	20	-	25
Total ANS potential	225	-	285

Total Pipeline Potential	Year 1980	Year 1985
Barrels per day	455 - 515	495 - 555

Source: TMC 1979

It is difficult to forecast throughput delivery of offshore oil inland from Washington. A number of factors are involved (the effects of which have not been fully determined), for example:

- The demand which may develop for Alaskan crude in Minnesota and Illinois refineries.
- The exchange arrangements which may be possible, trading offshore domestic United States oil and foreign supplies for Canadian oil.
- The future volume of Alberta and Saskatchewan heavy crude oil which may be licensed for export into Montana and Wyoming.
- The extent to which imports of products may be used to relieve crude oil shortages in the north central United States.
- The impact of potential fuel conversion from natural gas to oil in the refining area.
- Potential refinery expansion.
- Product demand growth.

However, there is and will be a demand for the transportation of crude oil inland, based upon three factors: 1) the demand of the refineries in the north central United States, which have no other source of crude oil supplies; 2) the demand for offshore crudes because of quality; and 3) a desire by North Slope producers to sell Alaskan oil to inland markets as this allows the best net sales price at Valdez, Alaska, compared to other non-west coast markets.

After examination of projected supply and demand, TMC has made the following assumptions:

- The market area requires a new source of crude oil, both light, sweet, and heavy from offshore sources.
- There will continue to be a surplus over west coast refinery capacity of 400-500,000 barrels per day.
- Conversion from natural gas to crude oil in the north central United States market area will not be significant.
- No further refinery expansion will take place until a long term supply of crude oil at a competitive price can be assured.
- Product demand in the market area served will increase at an average rate of 2.5 percent per year.
- Exchanges which might be arranged may require transportation of offshore oil to Edmonton.

Based on these assumptions, TMC has designed a system capable of transporting volumes of crude oil to Edmonton at average rates of 400,000 to 500,000 barrels per day.

Proposed Port and Onshore Storage Facilities

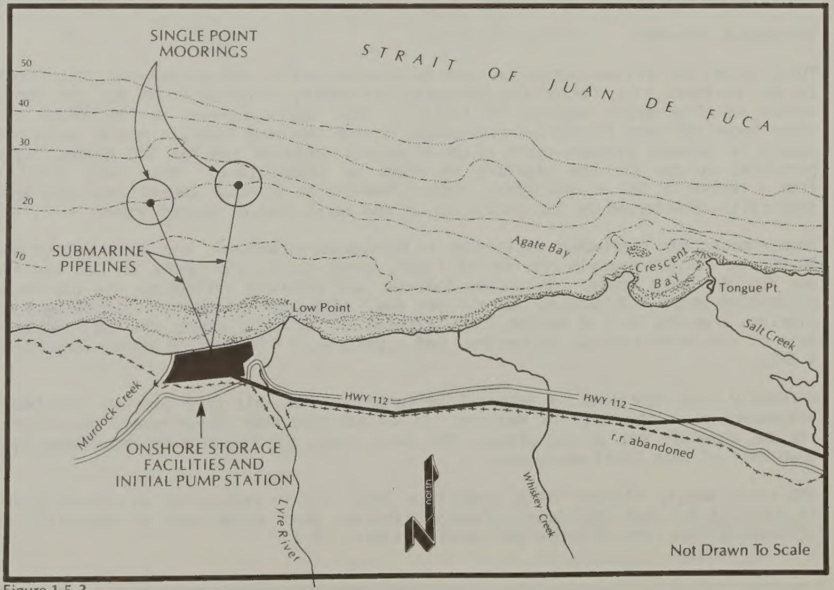


Figure 1.5-3

In the view of TMC, a demand for larger than forecast volumes is unlikely to occur within the foreseeable future. Should greater amounts be required and use of an expanded pipeline be guaranteed, TMC could enlarge the proposed system.

If inland markets required 500,000 barrels per day, the TMC system (with interconnections at proper locations) could provide up to 130,000 barrels per day of its 630,000 barrels per day capacity to Washington refineries, without further construction.

Sea Leg

The sea leg for this proposal is between tanker loading points at Valdez, Alaska or Indonesia, and Cape Flattery, Washington. The approximately 42 nautical miles from Cape Flattery to Low Point are considered in other sections.

Port and Onshore Storage Facilities

Port

The tanker unloading facilities would include two single point mooring systems (SPM) with mooring buoys, unloading lines, and two submarine pipelines for transferring the crude oil to onshore storage.

The proposed mooring system would be constructed at Low Point, Washington, at a water depth of approximately 120 feet, which is adequate for tankers up to the 200,000 dead weight ton class (see figure 1.5-3). Facilities for larger tankers are not considered necessary due to loading limitations in Indonesia and the size of tankers currently used by oil companies serving Valdez. Dredging would not be required.

Each mooring buoy would consist of a cylindrical steel buoy anchored to the sea floor by a multileg system of chains (see figure 1.5-4). Each chain would be connected to two anchors or anchor piles designed to hold the mooring under anticipated load conditions. A buoy would be equipped with a rotating mooring bollard and pipe manifold. A tanker would be bow-moored to this bollard and its oil pumped through a floating hose into the rotating manifold to the submarine pipeline. This arrangement would allow the tanker to weathervane about the buoy, always heading into the prevailing wind, wave, and current.

The effects of wind, wave, and current on the moored vessel and facility would be evaluated prior to final design.

The buoy hull would be a cylindrical, all-welded, steel structure which supports the turntable, buoy piping, oil hoses, and anchor chains. The hull diameter would be approximately 40 feet. It would be subdivided into water-tight compartments so that it would remain afloat if one section were damaged and flooded. It would also have a skirt-type fender to protect the floating oil hoses. Structural design of the hull would meet the requirements of the American Bureau of Shipping.

The turntable mounted on top of the hull would support the mooring bollard and the manifold which connects the unloading hoses to the submarine pipelines. All parts mounted on the turntable would rotate as one unit and stay in alignment with the ship as it weathervanes around the buoy.

Mooring System

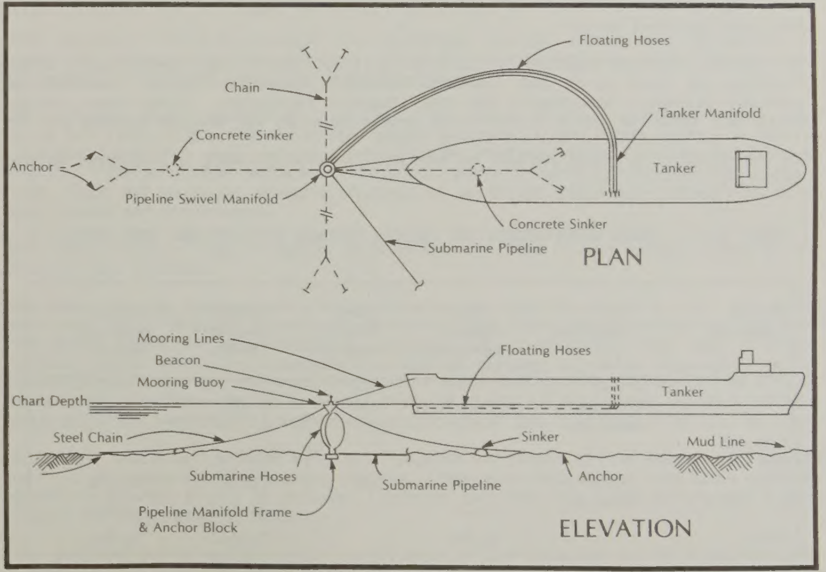


Figure 1.5-4

Source: TMC 1979

Each mooring buoy would have two strings of floating hose to accommodate the largest vessel using the terminal. The connection between the underside of the buoy and the submarine pipeline would be made of two strings of hose. These hoses would be of sufficient length to allow maximum lateral movement. Flotation devices would ensure that the underbuoy hoses stay clear of the seabed.

Each SPM would be supplied with two floating mooring hawsers. Short lengths of chain would be used at ends of the hawsers to reduce wear. These mooring lines would be permanently attached to the buoy.

Metering facilities would measure the quantity of crude oil unloaded from each ship. A group of four turbine meters would be required for each unloading line. An additional meter, installed between each group of four, would serve as a spare meter for either of the adjacent groups. A minicomputer would control meter runs and automatically adjust readout quantities. Counters and printers would be included in the meter installation with remote terminals in the control center at the onshore storage facility.

Support facilities and services would include communications, electric power supply, fire protection, waste treatment and disposal, bunkering service, potable water supply, and oil spill containment and recovery equipment.

Communication systems would include VHF marine radio; direct telephone circuits; conventional telephone and UHF radio, with portable units for the storage facility and other terminal areas.

Electricity would be supplied by the local utility. Power requirements would include lighting for work areas and roadways; cathodic protection system; communications systems; oil-water separators; and other support facilities. These power requirements are shown in table 1.5-3 for a system capacity of 500,000 barrels per day.

In the event of a power failure an emergency generator would be activated automatically.

TABLE 1.5-3 POWER REQUIREMENTS FOR ONSHORE STORAGE FACILITY AND PUMP STATION 1

System Capacity	Facility	Peak Demand (Megawatts)	Load Factor Percent	Monthly Megawatt Hours	Annual Megawatt Hours
500,000 bpd	Storage Facility	1.7	40	490	5,880
	Pump Station	9.8	100	7,056	84,672
Total		11.5		7,546	90,552

Source TMC 1979

Surface structures would be adequately grounded to the facility's grounding system to protect against lightning. This would include communication antennas, substations, buildings, and tanks. Incoming electric and communication services would be protected by lightning arrestors to prevent damage from lightning surges.

Smoke and heat detectors would be located in all buildings. Alarms would sound and a warning signal would light up in the main control center at the onshore storage facility. No fire detection devices would be installed on the single point mooring systems.

Ships offloading crude oil at Low Point would normally require a supply of bunker fuel for their outbound voyages. It would be the responsibility of the inbound ships to order this from suppliers in the Puget Sound area before arriving at Low Point. The supply company would dispatch fuel oil in a barge.

The line handling launches associated with port operations would be provided by private service companies working in the Puget Sound and Port Angeles areas. The ordering and payment for services would be the responsibility of vessel owners or agents. Service companies would have fuel supplies at their bases of operation.

A storage area for oil recovery and cleanup equipment would be located at the onshore facility.

Manpower for emergency operations would be obtained from the operating staff plus local fire departments and cleanup contractors. Detailed response actions are outlined in the oil spill contingency plan.

An oil spill containment boom would be deployed around the ship during the unloading operation. Any oil within the boom system would be transferred to the oily waste sump and pumped into the main cargo unloading line.

For a more dispersed spill, TMC would provide a skimmer-recovery vessel. For a large spill, the services, equipment, and expertise of the Clean Sound Cooperative would be utilized. Major petroleum operators in the Puget Sound area are members of this Seattle-based cooperative and have made regular capital contributions for equipment.

Submarine Pipelines

Two submarine pipelines are proposed to connect the single point mooring rigs to the storage tank filling line network at the onshore storage facility. These lines would be approximately 2.5 miles in length and approximately 48 inches in diameter. The final diameter would be selected on completion of design studies.

The tentative location of the submarine lines is shown in figure 1.5-3. Ultimate location would be determined upon completion of oceanographic and bottom sediment studies. The lines would be installed by either the lay-barge or the bottom-pull method. The technique selected would depend upon the availablility of suitable equipment on the west coast as well as other factors.

The capacity of each of the submarine pipelines would be approximately 80,000 barrels per hour (see table 1.5-4). Consequently, the submarine pipelines would be inactive approximately 74 percent of the time for the design capacity of 500,000 barrels per day.

The leak detection system would be different for inactive line conditions. When inactive, static line pressure would be monitored at the control room. Any reduction in pressure, beyond that attributed to temperature differences between the oil and the pipeline environment, would indicate the presence of a leak.

State-of-the-art sonic flow meters would be installed at the tanker unloading buoys and at the line termination. This computerized system would continuously monitor the flow at the mooring buoy and the receiving point at the onshore storage facility.

With this system, any deviation from a predetermined normal range of differences would activate alarm and data printout circuits at the control center. The dispatcher would shut down the operation, allow the system to become static, and monitor static pressures. If monitoring confirmed the presence of a leak, the oil in the line would be displaced with water, and the line would be taken out of service while repairs were made.

The submarine pipeline route would be patrolled twice daily by an observer in a launch. Relatively small amounts of oil would produce a sheen on the water surface that could be detected visually.

The lines would be constructed of heavy wall pipe. They would be protected by approximately 4 inches of reinforced concrete coating, and would be buried beneath the harbor bottom at sufficient depth to minimize the possibility of ship's anchor damage.

TABLE 1.5-4 ESTIMATED FREQUENCY OF TANKER CALLS

Tanker Size Class	Number of Port Calls Per Month	Number of Port Calls Per Year
Throughput of 500,000 barrels per day		
North Slope Crude Oil		
80,000 dwt	4.58	55
125,000 dwt	5.75	69
165,000 dwt	4.58	55
Subtotal	14.91	179
Foreign Crude Oil		
200,000 dwt	2.17	26
Subtotal	2.17	26
Total	17.08	205

Source: TMC 1979

On shore the lines would continue underground, beneath the beach to the storage facility where they would surface and tie into the metering and manifold piping. After backfilling the pipe trenches, the shoreline would be restored to its original condition.

Onshore Storage Facility

The onshore facility would be constructed on a 300 acre site at Low Point. The installation would contain storage tanks and appurtenances, piping systems, runoff holding basins and drainage networks, oil-water separators, oil measurement devices, and a control building, as well as support facilities and services. Other fixtures including the initial pump station, maintenance facilities and warehouse would also be located on the site. The layout of the proposed onshore storage facility is shown in figure 1.5-5.

Initially, eight 500,000-barrel tanks would provide 4 million barrels of storage. The tanks would be equipped with floating roofs with primary and secondary sealing devices at their perimeters to minimize hydrocarbon vapor emissions. If required for additional throughput or operational flexibility, space would be available for the construction of additional tanks.

The tanks would be equipped with other standard connections and fittings including water draw-off connections, roof drains, gauging platforms, spiral shell stairs, roof ladders, shell wind girders, manholes, clean-out doors, automatic tank gauges, and fire protection systems.

The tank shells would be supported on reinforced concrete ring foundations to provide stability and minimize nonuniform settlement. The area under each tank bottom would be graded, compacted, and surfaced with a sand-gravel and asphalt mixture.

Tank exteriors would be painted for protection against atmospheric corrosion, as would the interior bottom surfaces. Exterior bottom surfaces would be protected by means of a cathodic corrosion protection system.

Both 48-inch tanker unloading lines would be connected to a manifold which would allow oil from either line to be discharged into any of the eight tanks. A suction line would run from each tank to a booster pump suction manifold at the initial pump station. The manifolds would be centralized, where possible, to accommodate several tank lines and would be situated adjacent to perimeter dikes and roadways to allow easy access and maintenance.

The tanks would be high enough to provide gravity flow to the booster pumps in the initial pump station.

Two water holding basins would be constructed as shown in figure 1.5-5. One would hold oily water drained directly from tanks. The other would contain surface runoff which might, on some occasions, contain oil. The water from each of these holding basins would be processed as required through oil-water separators before being discharged. The oil-water separators would use gravity separation as a first stage, and air-flotation as a second stage process, to produce an effluent meeting anti-pollution requirements before being discharged into the Strait of Juan de Fuca.

Each tank would be enclosed by a dike capable of retaining the contents of a full tank in the event of a container rupture. The area occupied by the tanks would be graded to provide slopes of at least 1 percent away from the tanks and exposed piping toward the large holding basin.

The permeability of onsite soils to be used in the construction of dikes would be determined following completion of geotechnical studies. If these were found to be unsuitable, select offsite material would be hauled in and used for construction of an impermeable core in all dikes designed for impounding water or oil.

Earthwork would be designed to produce an approximate balance of excavation and embankment quantities. Surplus material that might result from the construction activities would be disposed of on the site in areas not occupied by permanent facilities. These disposal areas would be selected so that the surface contours, following deposition, compaction, and grading of the added materials, would blend with existing land contours.

The erosion potential of the disposal sites would be evaluated and measures would be taken to control erosion both during and after the construction period. These measures would include temporary and permanent runoff diversion structures, mulching, and revegetation. Until vegetation was reestablished, storm water runoff would be retained in settling basins below the disposal site to aid in the removal of sediments.

During construction, short-term storage of some excavated materials would be required. The sites for temporary storage would be dictated by construction activities. Where possible, the sites would be within the facility construction zone in order to minimize disturbance of areas not required by the installation. The material would be stockpiled with stable sideslopes and, if necessary, runoff would be ponded to aid in removal of sediment prior to discharge to natural water courses.

The proposed fire protection systems for the onshore storage facilities would include:

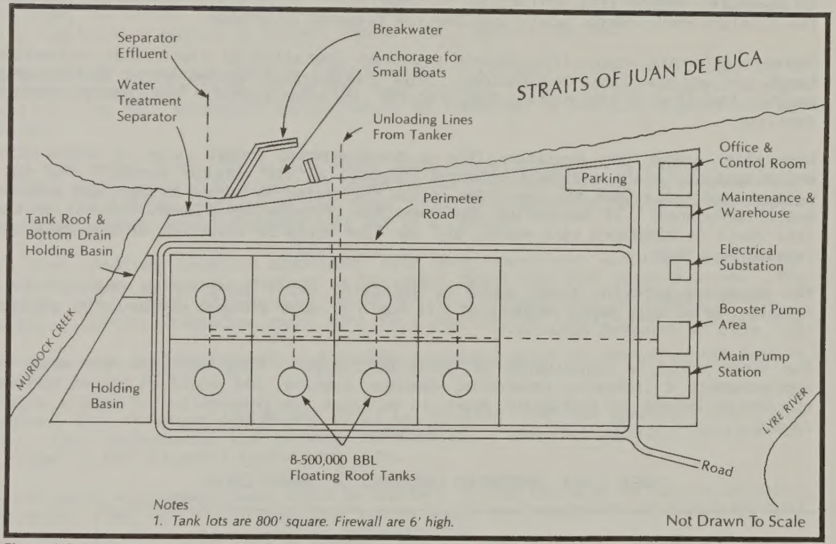
- A storage reservoir, diesel-driven fire pumps with a closed loop fire water distribution system, and hydrants located to provide coverage throughout the developed area.
- Foam connections on each tank with piping to the nearest road so that foam can be delivered from portable trailers and/or fire trucks to the rim seal area of each tank. The floating roofs would be provided with foam dams to concentrate the flow of foam within the seal area.
- An indoor control and instrument area protection system consisting of a permanently installed halon inert gas system. Portable and hand operated dry chemical units would also be provided for controlling interior building fires.
- A utility fire truck capable of towing foam trailers and equipped with hose reels, a twin agent chemical system, and a high pressure fog system.

Firefighting procedures and the detailed local design of the protection system would be developed in cooperation with regional firefighting groups that could lend assistance in the event of a major fire.

Water for personnel and the fire system would be supplied by the local water district. If this were not feasible, onsite wells would be developed.

Roads for operation, maintenance, and firefighting would be constructed around the perimeter of the onshore facility to provide access to each tank. These roads, as well as the main access road, would be asphalt-surfaced all weather roads provided with suitable drainage structures.

Onshore Storage Facility



Notes
1. Tank lots are 800' square. Firewall are 6' high.

Not Drawn To Scale

Figure 1.5-5

Source: TMC 1979

Septic tank systems for the disposal of sanitary sewage would be provided for the approximately 15 personnel on duty. Suitability of this arrangement would be verified by soil testing at specific sites before final design. If such tests indicate that the soils are not satisfactory, holding tanks would be provided and serviced by commercial septic tank pumpers and haulers. Temporary facilities consisting of field toilets and holding tanks would be provided for construction personnel. The contents of these tanks would be disposed of commercially. Sediments periodically removed from the oil-water separators would be disposed of in approved sanitary landfills.

Pipeline System

Pipeline Route

A 30-inch pipeline 148 miles long would run from the onshore storage facility at Low Point, Washington, to the international boundary at Sumas, Washington, where it would parallel another 30-inch line connecting Sumas with Edmonton, Alberta. At Edmonton, the new pipeline would link with existing systems to provide deliveries to the northern tier states.

The pipeline system would consist of mainline pipe, pump stations, mainline valves, scraper traps, and impressed current cathodic protection facilities. The capacity of the system would be 500,000 barrels per day.

The proposed pipeline route in Washington is shown in figure 1.5-1.

The selected route would use existing utility corridors where practical and for 44 miles share the right-of-way with an existing TMC pipeline from Burlington, Washington, to the Canadian border.

The proposed pipeline route would originate at the onshore storage facility at Low Point, Clallam County, Washington. After leaving the storage site the route would proceed due south, cross U. S. Highway 112 (approximately 0.5 mile south), and continue another 1.5 miles before intersecting with the Bonneville Power Administration (BPA) transmission line right-of-way. (See Map Addendum.)

The route would travel eastward across Clallam County parallel to the existing BPA right-of-way, cross the Dungeness River south of Sequim, and enter Jefferson County southeast of Blyn.

South of Port Discovery Bay, the route would turn northeast, to Oak Bay where it would cross under water to Indian Island before running southwest overland to Nodule Point on Marrowstone Island. From this point it would traverse Admiralty Inlet in Puget Sound, to Bush Point on Whidbey Island in Island County. At Bush Point the line would turn north to North Bluff and cross under Saratoga Passage to Camano Island at a point approximately one mile north of Lowell Point. On Camano Island, the pipeline would proceed north to Livingston Bay, and from there east to East Stanwood in Snohomish County. At East Stanwood the line would again turn north, paralleling state highway 530, to Conway, in Skagit County. There it would join an existing TMC right-of-way through Skagit and Whatcom Counties to the international boundary at Sumas.

The major rivers to be crossed are the Skagit River in Skagit County and the Nooksack River in Whatcom County. The major marine crossings, totaling 5.5 miles would be under Admiralty Inlet and Saratoga Passage in Puget Sound (see Map Addendum).

Pipeline

The pipe would be manufactured, tested, and inspected to meet latest requirements of the American Petroleum Institute (API) for high test pipe, API Specification 5LX. The pipe would be fabricated using the submerged-arc welding process. Material grade would be X60 with minimum yield strength of 60,000 pounds per square inch (psi).

Highway and railroad crossings, by county, are listed in table 1.5-5. Major and minor river crossings for the pipeline system are shown in table 1.5-6. Major marine crossings are presented in table 1.5-7.

TABLE 1.5-5 MAJOR ROAD AND RAILWAY CROSSINGS

Approx. Pipeline Mile	Road or Railway Description	County
0.5	Hwy. 112 (near Low Point)	Clallam
1.5	Hwy. 112 (near Low Point)	
4.0	Road (connecting Hwy. 112 & 101)	
15.0	Hwy. 101 (near Port Angeles)	
48.0	Hwy. 101 (near Port Discovery)	Jefferson
53.5	Road (near Oak Bay)	
55.0	Road (foreshore Oak Bay)	
56.5	Road (on Marrowstone Island)	
58.0	Road (on Marrowstone Island)	
69.0	Hwy. 525 (Whidbey Island)	Island
73.5	Hwy. 532 (Camano Island)	
77.0	Road (Camano Island)	
80.0	Hwy. 532 (Camano Island)	
86.0	Road (near Stanwood)	Snohomish
86.25	Burlington Northern Railway	
86.50	Hwy. 530 (near Stanwood)	
86.75	Hwy. 532 (near Stanwood)	
92.5	Hwy. 5 (near Conway)	Skagit
93.5	Hwy. 534 (near Conway)	
94.5	Hwy. 5 (near Conway)	
95.0	Burlington Northern Railway	
99.0	Road (near Mt. Vernon)	
100.0	Hwy. 536 (near Mt. Vernon)	
102.5	Hwy. 20 (near Burlington Pump Station)	
106.0	Hwy. 11 (near Burlington)	

TABLE 1.5-5 MAJOR ROAD AND RAILWAY CROSSINGS (Cont.)

Approx. Pipeline Mile	Road or Railway Description	County
106.5	Hwy. 5 (near Burlington)	Skagit (Cont.)
107.5	Burlington Northern Railway	
116.0	Hwy. 5 (near Samish Lake)	Whatcom
126.0	Road (near Bellingham)	
127.0	Burlington Northern Railway	
127 5	Hwy. 542 (near Bellingham)	
128.0	Chicago Milwaukee St. Paul and Pacific Railway	
131.0	Road (near Laurel Pump Station)	
134.0	Road (near Laurel Pump Station)	
135.0	Road (near Lake Fazon)	
135.0	Road (near Lake Fazon)	
136.5	Chicago Milwaukee St. Paul and Pacific Railway	
139.5	Burlington Northern Railway	
139.75	Hwy. 9 (near Nooksack)	
141.5	Road (near Nooksack)	
145.0	Chicago Milwaukee St. Paul and Pacific Railway	
146.0	Road (near Sumas)	
148.0	Road (USA/Canada Border)	

Source: TMC 1979

TABLE 1.5-6 MAJOR RIVER AND STREAM CROSSINGS

Approx. Pipeline Mile	Water Crossing Name or Description	County
0.25	Stream (near Low Point)	Clallam
0.5	Stream (near Low Point)	
3.0	Stream (near Disque)	
4.0	Stream (near Disque)	
6.0	Stream (near Joyce)	
7.75	Stream (near Ramapo)	
8.0	Stream (near Ramapo)	
8.25	Stream (near Ramapo)	
11.0	Stream (near Freshway Bay)	
12.5	Elwha River (near Port Angeles)	
15.5	Stream (near Port Angeles)	
18.0	Stream (near Port Angeles)	
18.5	Stream (near Port Angeles)	
19.5	Stream (near Port Angeles)	
20.5	Stream (near Port Angeles)	
21.0	Stream (near Port Angeles)	
22.0	Morse Creek (near Port Angeles)	
23.5	Stream (near Green Point)	
25.0	Siebert Creek (near Green Point)	
29.0	Stream (near Carlsborg)	
32.5	Dungeness River (near Sequim)	
37.5	Stream (near Blyn)	
38.5	Stream (near Blyn)	
46.0	Salmon Creek (near Fairmont)	Jefferson
47.0	Snow Creek (near Fairmont)	
53.0	Chimacum Creek (near Chimacum)	
55.5	Oak Bay (Puget Sound) (Salt Water)	
83.0	Port Susan (Skagit Bay) (Salt Water Crossing)	Island/Snohomish
91.5	Creek (near Conway)	Skagit
101.0	Skagit River (near Burlington P/Stn.)	
105.0	Samish River (near Allen)	
115.0	Friday Creek (near Alger)	
126.0	Whatcom Creek (near Bellingham)	Whatcom
133.0	Ten Mile Creek (near Laurel)	
138.5	Nooksack River (near Nooksack)	
141.0	Sumas River (near Nooksack)	
144.0	Creek (near Nooksack)	

Source: TMC 1979

TABLE 1.5-7 MAJOR MARINE CROSSING

	County	Length (miles)	Depth (feet)
Admiralty Inlet	Jefferson/ Island	3.25	400
Saratoga Passage	Island	2.25	350

Source: TMC 1979

The pipeline would be buried below the scour depth of streambeds. As required by Department of Transporation regulations, the cover over the pipeline would be a minimum or 48 inches for waterway crossings, unless rock excavations were encountered. The cover might then be reduced to 18 inches. At all stream crossings, the wall thickness of the pipe would be increased as a safety precaution; an additional thickness of anticorrosive coating would be applied; and either continuous concrete coating or individual concrete weights would be added to provide the weight necessary to keep the pipeline buried.

At canyons and gorges, with no other alternatives, the stream would be crossed by a suspension span or supported on steel and concrete structures.

Installation procedures would vary with stream width, depth, waterflow, and terrain. In most cases, the pipe would be fully assembled and tested before being placed in the streambed trench, then retested after backfilling.

Locations and sizes of other known crude oil, refined product, and natural gas pipelines which would cross the system are shown in table 1.5-8. Procedures would be developed to protect these pipes from damage during the construction of the TMC line. In addition, the pipes would be electrically insulated from each other and an aboveground cathodic protection test station would be installed to monitor the system for stray current between the lines.

TABLE 1.5-8 MAJOR UNAFFILIATED PIPELINE CROSSINGS PRIME ROUTE

Approx. Pipeline Mile	Pipeline Name or Description	County
95.5	8 inch Cascade Natural Gas	Skagit
103.0	16 inch Olympic Products	
127.0	16 inch Olympic Products	Whatcom
129.0	16 inch Olympic Products	
131.0	16 inch Cascade Natural Gas	

Source: TMC 1979

Joint use of right-of-way by pipelines and high voltage alternating current transmission lines would minimize the amount of land required for these corridors. However, such joint use would create interferences and electrical hazards that would be considered in the design, construction, and operation of the pipeline facilities. The magnitude of the induced voltage that could occur in the pipeline would be considered in the system design.

During construction, safety measures would be taken to prevent the induction of dangerous voltages onto the pipe, before lowering it into the trench. A solution to this problem is to maintain cable bonds from the pipeline to the AC transmission line grounding system and to portable steel mesh gradient control mats used at working positions along the pipeline.

After construction, voltages which could be hazardous might still be a problem. A system of bonds and insulated flanges coordinated with the design of the cathodic protection system would minimize the hazards to personnel and to the pipeline.

To prevent corrosion from pipe-soil contact, an external coating would be applied to all buried line pipe fittings and valves. An additional coating would be field-applied on river crossing pipe. In rocky areas, rockshield tape would be applied before installation.

The corrosion protection of the external coating will be supplemented by cathodic protection of the impressed current type. Rectifier stations and groundbeds will be positioned along the pipeline route at intervals to be determined after the pipeline has been installed.

Traps for launching and receiving pipeline scrapers would be provided at selected points on the system. The scrapers would be sent through the line at various intervals, depending on operating conditions, to remove solids built up on the interior pipe wall. Two launching and two receiving traps would be required.

Test taps will be placed at maximum intervals of one-mile and at crossings with other buried metallic facilities, to monitor the effectiveness of the cathodic protection and to check and nullify possible interference with them.

Main Line Valves

Table 1.5-9 summarizes the mainline block valves at river crossings, water crossings, and pump stations.

Main line valves would be of two types: (1) block valves which could be remotely or locally operated; and (2) check valves which would permit flow in only one direction. Check valves would be installed at the base, or along uphill sections of the pipeline and would prevent backflow during shutdown or rupture of the system.

TABLE 1.5-9 LOCATION OF MAIN LINE VALVES IN PIPELINE

Location			Remarks
Pipeline Mile 1/	County	Block or Check 2/	
0	Clallam	Block	Low Point onshore storage facility
13.0	Clallam	Block	Elwha River crossing
13.5	Clallam	Check	Elwha River crossing
32.0	Clallam	Block	Dungeness River crossing
33.0	Clallam	Check	Dungeness River crossing
43.0	Jefferson	Block	Salmon River crossing
44.0	Jefferson	Check	Salmon River crossing
47.0	Jefferson	Block	Fairmont pump station block valve
49.5	Jefferson	Check	To break downgrade east of Snow Creek
55.0	Jefferson	Block	Marine crossing to Marrowstone Island
55.8	Jefferson	Check	Marine crossing to Marrowstone Island
59.0	Jefferson	Block	Admiralty Inlet crossing
64.0	Island	Check	Admiralty Inlet crossing
70.0	Island	Block	Saratoga Passage crossing
73.0	Island	Check	Saratoga Passage crossing
83.0	Island	Block	Skagit Bay Marine crossing
83.5	Snohomish	Check	Skagit Bay Marine crossing
101.0	Skagit	Block	Skagit River crossing
101.5	Skagit	Block	Skagit River crossing
102.5	Skagit	Block	Burlington pump station block valve
121.0	Whatcom	Block	Lake Samish
124.5	Whatcom	Block	To break downgrade of Lookout Mountain
131.5	Whatcom	Block	To break downgrade into Ten Mile Creek
138.5	Whatcom	Block	Nooksack River Crossing
139.0	Whatcom	Block	Nooksack River Crossing
148.0	Whatcom	Block	International Boundary

Source: TMC 1979

Note: 1/ Mileages are approximate. Detailed route selection has not been made.

2/ The choice between block and check valve is subject to review at the final detailed design stage.

As required by Department of Transportation regulations, main line valves would be installed at each of the following locations:

- on the suction and discharge side of a pump station to permit isolation of its equipment in an emergency;
- on each line entering or leaving a storage facility to permit its isolation during an emergency;
- on the mainline at locations along the pipeline system to minimize damage from accidental discharge of crude oil, as appropriate for open country or populated areas;
- on each lateral takeoff from the main pipeline to permit the shutting off of the lateral line without interrupting flow in the mainline;
- on each side of a water crossing that is more than 100 feet wide from high-water mark to high-water mark;
- on each side of a reservoir holding water for human consumption.

Main Line Stations

Three pump stations would be installed along the pipeline system in Washington. Proposed station locations are listed in table 1.5-10.

TABLE 1.5-10 LOCATION OF PUMP STATIONS ON PIPELINE

Pipeline Mile	County	Station	Installed Horsepower	Pump Unit Complement
0	Clallam	Low Point	12,000	4x3000 HP
48.0	Clallam	Fairmont	12,000	4x3000 HP
102.5	Skagit	Burlington	12,000	4x3000 HP

Source: TMC 1979

The initial main line pump station would be located at the onshore storage facility site near Low Point. This station would include the same equipment and support facilities described below for a typical intermediate pump station, with some additions which would apply only to this initial station. This extra equipment would include booster pump units and a metering facility. The electric-motor-driven booster pump units would provide the necessary pressure to move the crude oil through the metering facility into the main line pump units.

Major equipment and support facilities at each pump station would include electric-motor-driven centrifugal pump units, surge relief tank (if required), launching and receiving scraper traps for pipeline cleaning equipment (if required), drain system, valving, pressure control valves, piping, control building, high voltage supply, transformer, walk-in switchgear housing, communications tower, heliport, access road, and lighting, as well as fencing around the boundaries of the station.

A pumping unit would consist of a horizontal, split-case centrifugal pump coupled to an electric motor. The overall size of the pumping unit would be approximately 7 feet wide, 20 feet long, and 10 feet high. The electric motor would be the largest component. The pump units would be designed to operate at a noise level of 85 dBA or less.

A drain system would receive oil drained from pumps or piping during inspections or repairs or in the event of a pump seal leak. A tank and pump would be installed to collect and return any drained oil to the main pumpline.

The control building at each pump station would house the supervisory control equipment required to monitor the pumping units, valve positions, flow rate, station pressures, and temperature conditions. It would also house the communications equipment.

A pipeline leak detection system would be a part of the supervisory control system. At each pump station, suction and discharge pressure would be telemetered to the supervisory control computers at the main control center and monotored for deviations and rates of change. Deviations as small as 1.0 percent of the pipeline throughput could be detected and would trigger a leak alarm within 2 minutes.

The alarm would be both audible and printed. Flow rate also would be monitored at all receiving and delivery points on the pipeline, as well as at selected pump stations. These values would be continuously telemetered to the supervisory control computers. Alarms would allow the dispatcher to identify the section where the leak was suspected, arrange to close block valves to isolate the section, and initiate the oil spill contingency plan.

Electric power for the pump stations would be provided by the utility companies serving the area. Overhead electric service lines would vary from 69 to 230 kV, depending on station horsepower requirements and service voltage available. A substation transformer would reduce the service voltage to that utilized by the motor. Circuit breakers and pump motor starters would be contained in a walk-in type switchgear housing located in the fenced substation area.

Table 1.5-11 shows the power requirements for the Washington system.

TABLE 1.5-11 PUMP STATION POWER REQUIREMENTS 1/

Station	Demand Megawatts	Monthly Energy Megawatts	Annual Energy Megawatt Hours
Low Point	9.8	7.056	84.672
Fairmont	10.3	7.416	88.992
Burlington	12.3	8.856	106.272

Source: TMC 1979.
1/ 500,000 barrel throughput.

Existing roads would be used where possible. They would be improved if required to ensure access under all weather conditions. At locations where no roads exist, new, permanent, all-weather roads would be built. Heliport facilities would be provided at all station locations to provide alternate access in case of impassable roads or emergencies.

Station sites would be equipped with fire detection devices independent of the main power supply. These devices would automatically shut down the station and isolate it from the mainline. The detection system would also alert the pipeline dispatcher at the main control center. The dispatcher would notify field operating personnel and local emergency response teams. Extinguishers and portable foam generating units would be available at the site.

Chain link fencing topped with barbed wire would enclose each station to discourage unauthorized entry. Additional security measures would be developed during the detailed design.

Delivery Facilities

There are no pipeline delivery facilities planned for Washington. Except for exchanges, Puget Sound refineries are dependent upon offshore supplies. The tanker berths of three of these cannot accept vessels over 70,000 dead weight ton. If the existing

Washington refineries desire pipeline deliveries from Low Point, then cross-over connections would be made from the new 30-inch pipeline at Burlington leading to Anacortes, and at Laurel leading to Ferndale.

Construction, Operation and Abandonment Phases

Construction Phase

Construction Schedules. Construction of the proposed TMC system would be accomplished by specialized construction crews simultaneously working on the various system facilities.

TMC would begin the first phase of construction immediately following approval. TMC estimates construction of the entire project can be completed within 24 months.

The following major project component construction times are required:

Port facility	20 months
Onshore storage facility	24 months
Main line stations - U.S.	14 months
Pipeline - U.S.	12 months
Marine crossings - U.S.	12 months
Pipeline - Canada	20 months
Main line stations - Canada	20 months

Although total construction period is shown as 24 months, TMC has indicated the system could be placed in service in 20 months as full onshore storage facilities are not required for initial operation.

A more detailed construction schedule is shown in figure 1.5-6.

Construction management and inspection would be performed by TMC personnel or under their supervision. They would be responsible for coordinating the activities of contractors, and assuring that the work was of acceptable quality and in accordance with the construction specifications. Additional inspectors would be assigned where items of special construction, such as river crossings, were involved.

Major construction materials would be purchased with adequate lead time to assure minimal delay before installation. Construction contractors would arrange for temporary stockpiling or warehousing at strategic points close to work sites. These sites would be rented or leased. Station and terminal sites would be used whenever possible. Existing pump station and onshore storage sites would be used for pipe stockpiling.

Following construction, restoration procedures would be implemented which would include cleanup activities and revegetation where necessary. River and shoreline banks would be stabilized. Permanent facilities would be landscaped and painted.

Port and Onshore Storage Facilities. The construction schedule for the port and terminal facilities is shown in figure 1.5-6.

Preliminary Construction Schedule

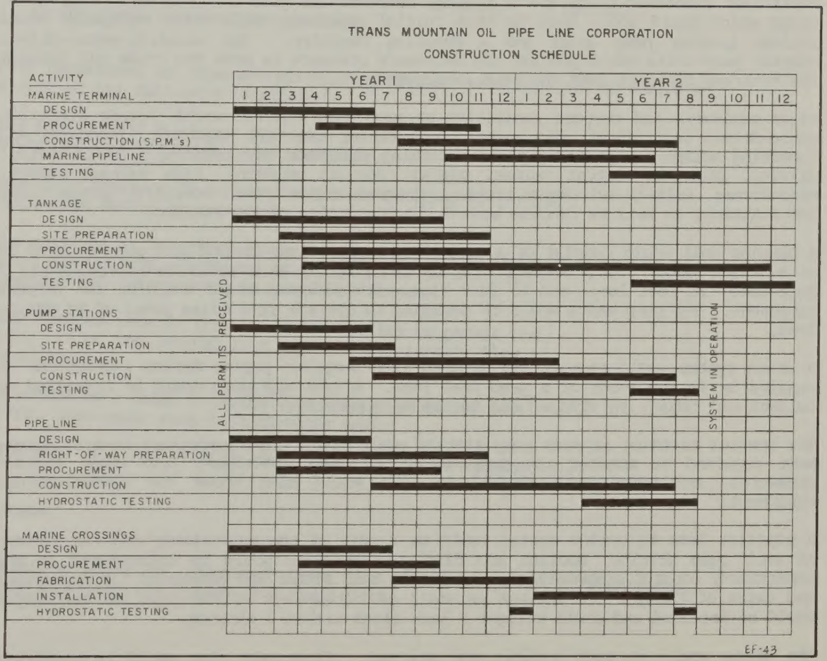


Figure 1.5-6

Source: TMC 1979

Total man months required for construction of the port and storage facilities is estimated to be:

Two SPMs	1,050 months
Submarine pipelines	1,950 months
Onshore storage facility	5,100 months
Total	8,100 months

The SPMs would be designed, fabricated, and installed by specialists. Final selection of SPM type would be made after detailed studies of wind, wave, tide, current, and bottom data have been completed.

The submarine lines would be constructed either by the lay barge or bottom-pull method.

Both techniques require the use of specialized marine equipment. The bottom-pull method would require the construction of a launchway ramp on shore. Burial of the pipelines beneath the harbor bottom would be required in both cases and trenching methods would be similar. Trenching would be accomplished by either hydraulic and air jetting after laying or by clamshell or other type dredge before laying.

All marine piping welds would be inspected by x-ray or gamma ray prior to applying the corrosion preventive and other coatings to the weld joint areas. Additionally, all elements of the piping systems would be hydrostatically tested in accordance with current codes and standards.

Civil construction at the onshore storage site would include clearing, grading, paving, building construction, and earthwork for tank dikes, roads, foundations, holding basins, and drainage structures.

The first task would be construction of access roads, followed by grading and laying of tank foundations and pads, so that tank erection could begin at the earliest possible date. Building raising and the installation of services and utilities would take place during the latter part of the construction period.

Final elements of civil construction would include fine grading, road and parking lot surfacing, landscaping, revegetation, and site cleanup.

The design, material fabrication, and erection of the storage tanks would be performed by tank contracting specialists. Material fabrication and forming and cutting steel plates would be done by the contractor before delivery to the site. Upon delivery, construction crews would erect the storage tanks. Plates would be welded using both automatic and manual techniques.

The tanks would receive protective coatings of paint following erection. Paint colors would be chosen to blend with the surroundings.

Tank erection would take approximately 13 months. Upon completion, the tanks would be tested hydrostatically by filling each with water.

Mechanical and electrical construction would be performed under contract during the latter 9 months of the construction period, following completion of the basic port facilities

The onshore piping system, including the main suction and fill systems for the tanks, roof drain system, and water-draw off system, would be constructed by pipeline contractors.

All elements of the completed piping systems would be hydrostatically tested in accordance with applicable codes and standards.

Disturbed areas not occupied by constructed facilities would be fertilized, mulched, and seeded to produce a ground cover which would retard storm water runoff and reduce soil erosion.

Original site drainage patterns would be preserved or restored where possible. Otherwise, new patterns would be established which would be compatible with surface drainage requirements Where necessary to control erosion, devices such as ditch checks and ditch linings would be constructed.

The grounds surrounding the control, office, and warehouse buildings would be landscaped and planted with shrubs and trees compatible with existing vegetation.

Pipeline System. The pipeline system from the onshore storage facility to the international boundary would be constructed over a period of approximately 8 to 12 months from the date that all permits were received. The major portion of the pipeline work would be done during April through November. Required construction personnel, by spread, are listed in table 1.5-12. Construction procedures would vary in some of the more restricted sections because of the specialized installation methods and equipment required. The total number of construction personnel required by month is listed in table 1.5-13.

Right-of-way agreements or easements would be negotiated with property owners. TMC would make one payment to property owners for easement and damages that might occur during construction. Other payments would be made to the landowner during the life of the project for damages that might occur during maintenance.

Generally, the right-of-way agreements obtained from public agencies and private landowners would convey to the pipeline company the right to survey the route, clear and grade the right-of-way to accommodate construction, install the pipeline, and provide access to the pipeline for operation and maintenance. TMC states the width of permanent right-of-way acquired would be 60 feet; however, an additional 15 feet may be required temporarily in certain locations to provide working space for construction equipment.

Each pipeline construction spread would be made up of several units organized for work to proceed in the following sequence: clearing and grading the right-of-way, hauling and stringing the line pipe, trenching, pipe bending, pipe laying and welding, applying external coating to field welds, lowering-in, backfilling, testing, and right-of-way cleanup and restoration.

TABLE 1.5-12 CONSTRUCTION PERSONNEL REQUIRED BY SPREAD
(Terrestrial Portions Only)

Classification	Typical Number Required
Field office and overhead	23
Right-of-way clearing and fencing	37
Right-of-way (grading)	7
Ditching (earth)	20
Ditching (rock)	19
Road crossing	11
Stringing	16
Bending	10
Pipe crew (alignment and stringer bead)	37
Welding crew	21
Joint cleaning, priming, and coating crew	12
Lowering	23
Tie-in (x2)	34
Testing crew	8
Utility crew	9
Backfilling and clean-up	25
Seeding, restoration, and revegetation	22
Total	334

Source: TMC 1979

TABLE 1.5-13 CONSTRUCTION PERSONNEL REQUIRED BY MONTH

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Personnel	100	234	334	334	334	334	334	334	334	334	334	334	334	334	100

Total Manhours: 4,352 per spread

Source: TMC 1979

The construction spread through mountainous or populated areas might be smaller than a cross-country spread. In such areas specialized personnel and equipment may be used to minimize congestion. These spreads would necessarily progress at a much slower rate (see table 1.5-14). The land use types that would be crossed by pipeline are shown in table 1.5-15.

TABLE 1.5-14 PIPELINE ROUTE PARAMETERS
(United States Portion)

Description	Number
Major rivers	2
Creeks	34
Marine crossings	2
Major highway or road crossings	32
Major railroad crossings	7
Major utility pipeline crossings	5
Percent rock excavation	4

Source: TMC 1979

TABLE 1.5-15 LAND USES CROSSED BY PROPOSED PIPELINE 1/
(United States Portion)

Area	Total Mileage	Urban	Argiculture/ Grassland	Forest/ Woodland	Other 2/
Olympic Peninsula (Clallam and Jefferson Counties)	62	1	16	41	4
Island County	23	1	7	11	4
East Puget Sound (Snohomish, Skagit, and Whatcom Counties)	63	1	33	25	4
Total	148	3	56	77	12

Source:

1/ Figures estimated from TMC land type by percent cover.

2/ Includes water and watershed areas.

Clearing would include removal of trees, brush, crops, and boulders. Large trees would be cut into manageable or marketable lengths and removed from the right-of-way. Removal of only the trees, brush, and crops necessary for construction and maintenance would be permitted.

Grading would include preparing the ground surfaces to permit placement of the pipeline at the desired elevation. Construction of access roads, stabilizing soil to support heavy equipment, and other work would be done as required. Existing roadways would be used whenever possible.

The trench would be open as briefly as possible, with stringing usually preceding trenching. When required, blasting would have to precede stringing to avoid damaging the pipe. When possible, a conventional trenching machine would be used, but backhoes, power shovels, drag lines, hand tools, rippers, or combinations would be utilized as required. In irrigated and prime agricultural land, double ditching would permit replacement of topsoil in a relatively unaltered condition. Double ditching would involve excavating, stock piling, and replacing the top soil separately from the subsoil. A minimum of 3 feet of cover over the pipe would be maintained.

Pipe-stringing trucks would transport the pipe in 40- to 80-foot lengths from storage yards to the pipeline right-of-way. Along the right-of-way, sideboom tractors would lay the pipe joints beside the trench for lineup and welding.

The trench bottom would be graded so that the pipe would contact the trench bottom throughout its length. The pipe would be bent both vertically and horizontally to conform to the terrain.

The pipe would be bent by placing individual lengths in bending machines. If field bending were not practical, manufactured or shop-made bends would be used.

Laying the pipe would include aligning it for welding, holding it in position with sideboom tractors during the first welding pass, and lowering it onto skids or blocks.

After the laying procedure, a welding crew would apply the remaining weld passes to match the thickness of the weld to the wall thickness of the pipe and would finish the weld by applying a cap approximately 1/16 inch in thickness.

The pipe would be lifted and lowered into the trench by two or more sideboom tractors acting in unison and spaced so that the weight of unsupported pipe would not cause buckling or other damage.

Angle dozers, crawler-mounted side-pull backfillers, and auger backfillers would move dirt from the spoil bank to the ditch. The backfilled earth would be compacted to minimize later settling. In certain areas where damage to the coating might occur, additional protection would be provided by padding the trench with select backfill material. In rocky areas the pipe would be futher protected with rock-shielding materials.

Soil excavated in the trenching operation would be returned to the trench as backfill. Excess soil would be crowned up over the trench so that normal settlement would not create a depression in the trench line. Any excavated material deemed unsuitable for use as backfill would be disposed of in a manner acceptable to the land owner.

Pipeline crossings of highways, roads, and railroads would be accomplished by various construction methods, generally determined by the authorities having jurisdiction over the structure. Major highway and railroad crossings are normally bored and cased with a steel pipe large enough to allow the installation of the main or carrier pipe through the casing. Where roads are unimproved or boring is impractical, the crossing may be made by open cutting. This can be accomplished by opening only half of the road at a time. This method of construction also allows the installation of the pipeline with or without a casing.

Along the route a number of streams would be encountered with different width, depth, water flow, and terrain. Submerged crossings would be constructed so that the pipe would be positioned below the scour level of the streambed. The ends of the crossing pipe would extend into the banks of the waterway beyond the point of high water scour.

Design of the crossings would be in accordance with the requirements of permitting agencies. The method of excavation and construction would depend on the characteristics of the waterway.

Excavation of the underwater trench would be accomplished by the use of backhoes, draglines, or clamshells. In shallow waters this equipment can rest on the bottom. For deep water excavation, it would be mounted on barges, equipped with power winches and stabilized by anchor to the stream bottom or by cable to the banks. As excavation of the trench progresses, the barge would be repositioned by operation of winches. The excavated material would be placed on the stream bottom adjacent to the ditch and used as backfill after the pipeline is in place. If the crossing permit required that the excavated material be replaced with select fill, it would be loaded on barges and carried to shore for disposal.

Streams with sand bottoms and flowing surface water can be "wet excavated" by means of a dredge or dragline. Sand bottomed streams carrying subsurface water may be dewatered with well points and dry excavated with a dragline.

If the stream bottom contains solid rock, drilling and blasting would be necessary to secure the needed trench depth. As on land, blasting for stream crossings would use multiholed, low intensity charges sufficient to fracture the rock without scattering debris over large areas.

The construction procedure for stream crossings would include welding pipe sections on land, examining the welds, applying protective coatings, adding weight in the form of a concrete coating to the pipe as required; and hydrostatically testing the pipe sections. All work to be done on the pipeline would be completed on land before its placement in the stream. The crossing pipe would be retested after installation as a part of the testing of the completed pipeline. Empty pipe would be carried or floated into position by floats tied to the pipe, and lowered into the trench by disconnecting them. On short and shallow crossings, the pipe would be placed directly in the trench with sideboom tractors.

After the pipe is in place, the trench would be backfilled using the excavated or other material. The trench line and banks of the stream would be restored and revegetated. Riprap or other materials would be placed on the banks for stabilization and to prevent erosion. To the greatest extent possible, all major stream crossings would be scheduled for installation during the normal period of low streamflow, or during a 3-month period designated by the appropriate state agency which is responsible for the protection of fish and wildlife.

When constructing the line through marshy areas, special backfill material such as bentonite clay, which forms a watertight barrier, could be utilized if a drainage potential existed. These procedures would be addressed in more detail in construction specifications. An environmental inspector representing TMC would be present during construction and would cooperate with the appropriate agency to see that special requirements were satisfied.

Drainage ditches and irrigation canals that cannot be crossed by open cutting would be crossed by boring underneath or spanning overhead as required by the agency with jurisdiction.

Submarine Pipeline Crossings. The final design of the crossings of Admiralty Inlet and Saratoga Passage would determine the exact method of construction. Basically two methods are available for the manufacture and installation of a submarine crossing: the pull method and the lay-barge method.

Depending on marine traffic, the nature of the bottom, an the extent of cross current velocity, the pipeline may be buried. In shallower water it is possible to use a dredge to excavate a trench prior to installation of the pipe. After laying the pipeline, currents may be sufficient to backfill the trench; otherwise gravel would be dumped from barges or deposited by bucketing gravel into the trench.

In addition to standard mill testing of all pipe and fittings hydrostatic testing would be performed after construction and before the line placed in operation. This test would be conducted in accordance with DOT regulations. It would involve filling the line with a suitable liquid test medium, usually freshwater, to a predetermined internal pressure. The pressure would be equivalent to a minimum of 1.25 times the internal design pressure of the pipe. The test pressure would be maintained for a period of 24 hours.

Water for testing would be obtained from local streams or rivers where available. The water would be be transferred from test section to test section unless local restrictions require returning the water to the source. Water used for testing would be fresh, free of precipitates, sewage, and oil, with a pH factor of 6.7 to 7.2. After testing the line, the water would be made suitable for discharging into watercourses.

Markers would identify the owner of the pipeline and include other information such as material transported and location and telephone number for contact in case of emergency. Pipeline markers, suitable for observation from the air, would also be installed for use by the line flyer.

Terrace structures would be installed to divert surface waterflow and to prevent washouts along the trench line. Seeding, mulching, and other methods of soil stabilization would be specified in construction specifications. Revegetation plans for crossing public lands would be those approved by agencies having jurisdiction.

Restoration procedures on privately owned agricultural lands would be determined in preconstruction agreements with owners.

Temporary land-use areas such as access roads, staging and assembly areas, stockpile and warehouse sites would be stabilized The land would be returned to the owner in the condition specified in the lease agreement.

Main Line Stations and Delivery Facilities. The main line stations would be constucted over a period of approximately 12 months. Table 1.5-16 and 1.5-17 list construction personnel required for a typical pump station. It is estimated that a maximum of 23 workers would be required at peak construction periods for a typical pump station.

TABLE 1.5-16 PUMP STATION CONSTRUCTION PERSONNEL REQUIREMENTS

Activity	Number of Persons
Site preparation and civil	5
Mechanical	6
Electrical	6
Erection	5
TMC inspector	1
Start Up	5

Source: TMC 1979

TABLE 1.5-17 CONSTRUCTION PERSONNEL REQUIRED BY MONTH

Month	1	2	3	4	5	6	7	8	9	10	11	12
Personnel	5	5	5	10	23	23	23	23	23	10	5	3

Source: TMC 1979

Construction of the control building and installation of the various electrical instrumentation and control systems would proceed concurrently with other construction work.

Restoration procedures would include removal of contractor equipment and materials, landscaping, and painting. Native trees and shrubbery would be established on unpaved areas where possible. All outdoor piping equipment, structures, and control buildings would be painted to blend with the surroundings.

Construction power would be available from electric utilities serving the areas, except for the Low Point site. No power is available here during the initial construction period, so portable facilities would be utilized.

During construction, three phase power, 10kW @ 440 volts, and single phase power, 15kW @ 120/240 volts would be required.

Discussions with the utility companies indicate electrical energy would be available. Transmission line connections would be made by the utilities at TMC's expense. For the Low Point terminal, 4.5 miles of new transmission line would be built to connect the facilities to the existing 69 kV network. Substations required to transform transmission line voltages to utilization voltages would be installed by TMC.

During construction, potable water would be provided by a contractor. At the Low Point site, permanent water facilities would be installed using wells and a treatment plant.

The station piping would be designed and constructed in accordance with codes and regulations in the United States and Canada. The design pressure of the station piping would be 1440 PSIG (American National Standards Institute 600 pound rating). All buried piping would be coated, wrapped, and cathodically protected.

There will be no delivery facilities planned for Washington.

Operation Phase

A permanent staff of TMC personnel would be responsible for operation and maintenance of the entire system. Operation control would be from a centralized but yet undetermined location.

Maintenance personnel stationed at permanent locations would be responsible for routine maintenance and repair. Major repairs and maintenance would be handled by contractors.

Port and Onshore Storage Facilities. Port operations would be controlled and monitored from a local control center at Low Point. Terminal dispatchers, reporting to the terminal superintendent, would be in complete charge of the tanker unloading and onshore storage facilities.

Tanker deliveries would be scheduled by the shippers in accordance with long-term programs submitted to TMC's operations manager. The operations manager would review the schedules and negotiate changes that might be required to minimize terminal congestion and maintain crude oil receipts within the capabilities of the port and pipeline system.

An inbound tanker would advise the terminal of its estimated time of arrival 24 to 36 hours before reaching port.

Mooring would be accomplished with or without the aid of tugs depending on size of ship and weather conditions. Support vessels would be required for deployment of unloading hoses and oil spill containment booms, for personnel transfer, and to assist with bunkering and provisioning of tankers.

Routine maintenance of all terminal facilities would be performed on a regular schedule by permanent staff. It would include inspection, testing, and lubrication of valves, pumps, motors, and other equipment and machinery in the mechanical and electrical systems, as well as general building and ground maintenance.

Major maintenance such as tank painting and mechanical overhaul of the booster pumps would be performed by specialized contractors. All contract work would be under direct supervision of permanent personnel.

For maintenance of submarine hoses and anchor chains, a craft equipped with suitable lifting gear and diving equipment would be required. Regular inspection, maintenance, and repairs of buoys, hoses, chains, and anchors would be required for operation. Hoses would be replaced regularly. Drydocking of buoys might be required every three to five years, depending upon conditions at the site. Drydocking of the buoys might take one month. An initial 2 to 3 years operating experience would determine if this out-of-service could be accommodated or whether a spare Single Point Mooring would be needed.

Air emissions at the port during operation would be from tanker operations and from the tanks. Since floating roofs with sealing devices would be installed on the tanks, a vapor recovery system at the onshore storage facility is not proposed.

The operation of the pipeline system would be controlled by pipeline dispatchers at the main control center. The main line stations would be designed for unattended operation and would be controlled remotely by the pipeline dispatcher with a computer-assisted supervisory control and data acquisition system.

The system as proposed would have a reliability of 99.9 percent. Through this system the port and pipeline dispatchers would be aware of the status of all equipment. Failures would be immediately indicated by alarms. The dispatchers would then take action to correct the condition. If the problem could not be handled from the main control center, the dispatcher would call field personnel to correct the condition. The leak detection system, as described elsewhere, would be a separate function of the supervisory control system.

Company personnel would handle routine maintenance. Major repair or maintenance for the pipeline and main line stations would be handled by contract.

Surface conditions on and near the pipeline right-of-way would be inspected by a line flyer every 2 weeks as required by Department of Transporation regulations. The flyer would report any construction activities near the pipeline which could result in damage to it, oil leaks, and potential threat of erosion and flooding.

Underwater crossings of navigable waterways would be inspected to determine their condition at intervals not exceeding 5 years, as required by Department of Transportation regulations.

After system completion energy requirements based on a throughput capacity of 500,000 barrels per day are listed in table 1.5-18.

TABLE 1.5-18 ELECTRICAL POWER REQUIREMENTS
(System Capacity 500,000 barrels per day throughput)

Facility	Location	Utility	Supply Voltage (kV)	Peak Demand (Megawatts)	Load Factor Percent	Monthly Megawatt Hours	Annual Megawatt Hours
Marine Terminal	Low Point	Clallam County P.U.D	69	1.7	40	490	5,880
Pump Station	Low Point	Clallam County P.U.D	69	9.8	100	7,056	84,672
Pump Station	Fairmont	Puget Sound Power & Light Company	69	10.3	100	7,416	88,992
Pump Station	Burlington	Puget Sound Power & Light Company	115	12.3	100	8,856	106,272
Total			—	34.1	--	23,818	285,816

Source: TMC 1979

To provide communications, micro-wave voice channels would be leased from a common carrier. Control would be provided by a pipeline control system using a computer-assisted supervisory and control network, as well as a station control system capable of independent operation and protection in the event that communications are lost.

Voice communications would be provided by one micro-wave channel in conjunction with a VHF (very high frequency) radio system. Local voice communications between a station and a mobile, or between mobile and mobile, would be via VHF repeater. These repeaters would be located at the micro-wave sites. A sufficient number would be provided to ensure radio coverage of all stations, a high percentage of the pipeline right-of-way, and the highway paralleling the pipeline.

Digital data and control transmissions would be provided by another micro-wave channel in conjunction with a UHF (ultra high frequency) radio system. This channel would be sized to provide a computer system update at least every five seconds.

Abandonment Phase

Future situations could make the operation of the proposed TMC system unfeasible. Conditions such as insufficient supply of crude oil or other economic difficulties could terminate the operation of the port and onshore storage facilities, pipeline system, and delivery facilities. Terminating operations would lead toward abandonment and possible disposal of all or portions of the entire system.

Port and Onshore Storage Facilities. Should abandonment procedures be implemented at the port, there would be a determination as to other uses of the single point moorings. If no other use were found, then the structures would be dismantled and removed along with the support facilities. Crude oil remaining in the system would be drained to the onshore storage facility and the shore connections possibly removed for salvage. The submarine pipelines would be drained, cleaned, and then filled with seawater for abandonment.

Abandonment of the onshore storage facility would require withdrawing the crude oil from the equipment. All storage tanks would be removed from service, dismantled, and disposed of. After removal of the storage tanks and associated equipment, the total land area of the site would be cleaned of residual equipment and graded for final cleanup. At that time existing zoning and land use regulations, would determine the future use of the property.

Pipeline System. If the pipeline system were abandoned, removal of crude oil from the pipeline could be accomplished by displacing it with water obtained from local sources. Selected pumping units would be used to gradually displace the oil and water into delivery facilities. If removal of the water from the system were required, truck transport would deliver the water to oil-water separators. Retaining water in the pipeline system would require addition of a corrosion inhibitor.

Removal and salvage of the line pipe and mainline valves would require activities similar to construction of the system, but with a simplified work scope. Some sections of the pipeline might not be removed; for example, river or road crossings. In such cases, the ends of the pipeline on both sides of the crossing would be sealed and covered with soil. Additional backfill might be required to restore the right-of-way to its original condition. The pipeline cathodic protection system would be disconnected and removed in the event of removal and salvage of the pipe.

Mainline pumps and motors would be disconnected and stored or removed for other uses.

Support facilities would be taken out of service in accordance with standard procedures and safety regulations. Movable items would be sold or salvaged.

Cost Estimates

Construction Costs

The project cost estimate summary is shown in table 1.5.-19 and 1.5-20. The total project estimate for the 500,000 barrel per day system within the United States is $200 million based on January 1, 1979, dollars. The total Canadian portion of the proposal is estimated to be $383 million based on January 1, 1979, Canadian dollars. This estimate includes contingencies, taxes, environmental studies, engineering, and construction management.

Escalation, interest during construction, cost of line fill (649,450 barrels), working capital, and debt expenses are not included.

Detailed cost estimate summaries are presented in tables 1.5-21 through 1.5-25.

Summary estimates have been based on January 1, 1979, dollars with power costs based on pumping 100 percent Alaskan crude oil.

TABLE 1.5-19 SUMMARY COST OF THE TRANS MOUNTAIN PIPE LINE SYSTEM 1/
(Thousands of Dollars, January 1, 1979, price levels)

Construction Cost 2/		
Tanker unloading facilities (2 SPMs)	$	28,600
Submarine pipe lines (2 -2.5 miles)		17,100
Onshore storage facilities		45,800
Pipeline system:		
Low Point - International boundary		108,500
Total	$	200,000

Source: TMC 1979

1/ 500,000 bpd throughput.

2/ Construction cost includes contingencies, taxes, environmental studies, engineering, and construction management, but excludes interest during construction, escalation, cost of line fill (649,450 barrels), and working capital and debt expenses.

TABLE 1.5-20 CONSTRUCTION COSTS
INTERNATIONAL BOUNDARY TO EDMONTON 500,000 BPD
(Thousands of Dollars, January 1, 1979, price levels) 1/

ITEM	COST
Pipelines	$ 274,688
Stations	59,038
Miscellaneous facilities	900
Engineering management	13,385
Contingency	34,801
TOTAL	$ 382,812

Source: TMC 1979

1/ Canadian dollars.

TABLE 1.5-21 COST ESTIMATE SUMMARY OF
PORT FACILITIES AND SUBMARINE PIPELINE
(Thousands of Dollars, January 1, 1979, Price Levels)

Description		
Single Point Mooring System		
Basic structures (SPMs)		$ 16,800
Oil spill containment		1,190
Miscellaneous		255
	Subtotal	$ 18,245
Unloading facilities		4,505
Submarine pipe lines		
2 - 48-inch lines, 2.5 miles in length		11,550
Metering facilities		2,150
	Subtotal	$ 36,450
Contingencies at 10 percent		3,645
	Subtotal	$ 40,095
Sales and use tax		2,005
Environmental studies engineering and construction management		3,600
	Total	$ 45,700

Source: TMC 1979

TABLE 1.5-22 COST ESTIMATE SUMMARY OF ONSHORE STORAGE FACILITIES--LOW POINT
(Thousands of Dollars, January 1, 1979, Price Levels)

Description		
Land (300 acres)		$ 1,160
Pipe		833
Valves and Fittings		1,780
Construction		1,664
Buildings		564
Electrical equipment		716
Tanks (4 million barrels)		28,000
Supervisory and Communications		500
Vehicles and other work equipment		132
Auxiliary Systems and miscellaneous		1,321
	Subtotal	$ 36,670
Contingencies 10 percent		3,667
	Subtotal	$ 40,337
Sales and use tax		2,017
Environmental studies, engineering and construction management		3,446
	Total	$ 45,800

Source: TMC 1979

TABLE 1.5-23 COST ESTIMATE SUMMARY OF PIPELINE AND STATIONS
(Thousands of Dollars - January 1, 1979, Price Levels)

Right-of-way and land		$	3,064
Pipe (42,091 tons)			25,255
Mainline block valves			1,440
Pipeline construction			34,900
Pump stations			7.676
Supervisory and communications			500
Vehicles and work equipment			600
Miscellaneous			3,000
	Subtotal	$	76,435
Contingencies at 10 percent			7,644
	Subtotal		84 079
Sales and Use Tax			2,109
Environmental studies, engineering and construction management			5,219
	Total	$	91,400

Source: TMC 1979
Cost of line fill (649,450 barrels) not included in this estimate.

TABLE 1.5-24 COST ESTIMATE SUMMARY OF MARINE CROSSINGS
(Thousands of Dollars - January 1, 1979, Price Levels)

	Admiralty Inlet	Saratoga Passage
Pipe	$ 1,020	$ 729
Coating and concrete	302	217
Other materials	1,320	942
Pipe make-up	1,030	731
Plow	425	425
Tow	397	397
Installation	3,200	3,093
Subtotal	$ 7,694	$ 6,534
Contingencies at 10 percent	769	653
	8,463	7,187
Sales and use tax	200	150
	8,663	7,337
Environmental studies, engineering and construction management	550	550
Total	$ 9,213	$ 7,887
Combined Total		$ 17,100

Source: TMC 1979

Annual Operating Costs

Estimated annual operating costs are listed in table 1.5-25.

TABLE 1.5-25 ANNUAL OPERATING COSTS 1/
TRANS MOUNTAIN OIL PIPE LINE CORPORATION
(Thousands of Dollars - January 1, 1979, Price Levels)

	U.S. portion	Canadian portion
Transporation	$ 4,500	$19,300
Maintenance	2,100	3,700
Administration	1,400	3,600
Ad valorem taxes	4,000	7,700
Total per year	$12,000	$34,300

Source: TMC 1979
1/ 500,000 bpd throughput.

Abandonment Cost

Estimates have not been made of the expense required to abandon the proposed system. Such expenses are included in the Interstate Commerce Commission's rate method, but were not included by Department of Energy in their tariff estimates. If a dismantling fund is required it would add to the transportation costs. In the case of the Trans Alaska Pipeline System this charge in the tariff is 9.6 cents per barrel.

Net Energy Balance

TMC has not furnished information concerning net energy balance.

Contingency Plans

This section summarizes the contingency plan which would be prepared for the TMC system before beginning operation.

The preparation of a comprehensive written emergency plan is required by Section 454 of "Liquid Petroleum Transporation Piping Systems," (ANSI B31.4 - 1974), and by the U.S. Department of Transporation Rules and Regulations, Part 195, Transporation of Liquids by Pipeline, subpart F, paragraph 195.402

A comprehensive contingency plan for a facility like the TMC system would not be prepared until the later stages of project development, when the detailed design was essentially complete, operating procedures and systems were more precisely defined, and environmental impact statements at the federal and state levels were accomplished.

The development of the contingency plan would be based in part on:

- Discussions with the Port Authority, U. S. Coast Guard, and other agencies to develop safety requirements for the berthing facility;
- Determination of the final locations for the pipeline system, stations, and delivery facilities.

1.6 Authorizing Actions and Interrelationships with Other Policies, Plans, and Projects

Significant interrelationships of various federal, state, and local governments and private industry with the Northern Tier Pipeline Company, Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation proposals are discussed in this section. For the most part these involve authorizing actions required for approval of the proposed crude oil transportation systems. How the proposals interrelate with the National Energy Plan, the Public Utilities Regulatory Policy Act of 1978 (public law 95-617), and Executive Order 12114, has been discussed in the Introduction which provides the background of the Environmental Statement.

Related Legislation and Regulations

Trans-Alaska Pipeline Act

The Trans-Alaska Pipeline Act (Public Law 93-153), authorized construction of the Trans-Alaska Pipeline from Prudhoe Bay to Valdez. It amended the Mineral Leasing Act to prohibit export of crude oil to a non adjacent foreign country if transported by a pipeline which received a right-of-way under the Mineral Leasing Act. Crude oil transported by the Trans-Alaska pipeline is subject to this prohibition.

Alaskan oil represents significant amounts of the forecasted throughputs of the four proposals considered in this Environmental Statement. The Trans-Alaska Pipeline Act created a special liability scheme. Vessel liability for spilled oil is limited to $14 million per incident. Claims up to $100 million are to be paid from the Trans-Alaska Pipeline Liability Fund which is maintained by a levy of five cents per barrel of pipeline oil loaded on tankers for shipment to U.S. ports. Liability extends to injury, destruction, or loss of natural resources.

Marine Mammals Protection Act Amendments

Section 5 of the Marine Mammals Protection Act Amendments of 1977 (Public Law 95-136), forbids authorization of construction or expansion of any crude oil "terminal, dock or other facility" in Puget Sound that may result in an increase in the amount of crude oil being handled by such facility. The law permits such expansions only to meet market demand in the state of Washington.

Similar legislation was passed in 1977 by the Washington State Legislature. This state and federal legislation prohibits the Cherry Point and Burrows Bay Port Alternatives of the TMC and NTPC proposals addressed in Chapter 9.

Water Pollution Control Act

The 1977 amendments to the Federal Water Pollution Control Act establish oil spill liability limits that would apply to the NTPC, NEC, and TMC proposals. Under these amendments, liability for inland barges is limited to $125 per gross ton or $125,000, whichever is greater. For all other vessels liability is limited to $150 per gross ton or $250,000, whichever is greater. Liability for oil transfer and storage facilities is limited to $50 million. There is no limitation if it can be shown that the spill was the result of gross negligence on the part of the polluter. Tanker and terminal owners are required to maintain evidence of their financial ability to pay these amounts.

Court Decisions

In March 1978, a provision of the Washington state tanker law prohibiting tankers larger than 125,000 dead weight ton in Puget Sound was invalidated by the U.S. Supreme Court (Ray v. Arco). Subsequently, the Secretary of Transportation issued an interim navigation rule which effectively reinstated the ban pending a formal rulemaking by the U.S. Coast Guard.

The Coast Guard issued a draft Environmental Statement in April 1979 on its proposed rulemaking which would prohibit laden tank vessels larger than 125,000 dead weight ton from transiting Puget Sound while enroute to a U.S. port. This proposed rulemaking, if implemented, would limit the size of tankers that could use the proposed NTPC port facility at Port Angeles to 125,000 dead weight ton.

Authorizing Actions

Table 1.6-1 summarizes federal, state, and local approval requirements for the NTPC, NEC, and TMC proposals. Kitimat Pipe Line Ltd's proposal would require Canadian approval and is not included in Table 1.6-1.

The KPC proposal requires approval from Canadian National Energy Board and the TERMPOL Committee

The Canadian National Energy Board (NEB) will prepare a technical evaluation for a certificate of public convenience and necessity. The NEB findings will be reported to the Canadian Federal Cabinet for decision. The TERMPOL Committee will prepare a technical evaluation of the application for a port facility in terms of necessary approvals. These findings also go to the Federal Cabinet for decision.

Interrelationships

The NEC, KPL, and TMC proposals would be subject to the U.S.-Canadian Hydrocarbon Pipeline Treaty of January 28, 1977. This Treaty ensures uninterrupted transmission of hydrocarbons to the territory of another nation. No public authority in either nation may impose monetary charges on pipelines. No charges may be applied to the hydrocarbons in transit.

In addition to, and often as a part of, the permit approval requirements summarized in Table 1.6-1, other federal, state, and local agencies would provide advisory roles in the permitting process. A variety of agencies have ongoing programs which would significantly affect or be affected by the NTPC, NEC and TMC proposals.

U.S. Federal Government

Department of Agriculture.

Forest Service. If the NTPC or NEC proposals were approved the Forest Service would provide BLM with right-of-way grant stipulations applicable to National Forest lands. The Forest Service would be responsible for ensuring compliance with applicable regulations in National Forests for the duration of the grant.

Soil Conservation Service. This agency provides technical assistance to private landowners, state and federal agencies concerning soil capabilities, erosion control, and land use planning. It has responsibility to ensure that impacts to prime and unique farmlands are adequately considered in federal decision making such as pipeline construction permits, and to aid in soil rehabilitation to land impacted by the pipeline system.

Department of Commerce

National Oceanic and Atmospheric Administration (NOAA). NOAA administers the Coastal Zone Management Act of 1972, as amended, to assist participating states in meeting increased and competing demands being made upon their coastal zones. NOAA has approved the Coastal Zone Management Program of Washington State which addresses energy facility siting such as crude oil transporation systems.

The National Marine Fisheries Service (NMFS), as an agency of NOAA, provides recommendations concerning marine estuarine, anadromous and inland commercial fisheries resources for Corps of Engineers permits. NMFS must be consulted if threatened or endangered marine mammals, fish or plants might be affected. Through consultations (and contracts in the case of the NTPC proposal) NOAA and ES team specialists concluded that no threatened or endangered species within NOAA jurisdiction would be affected by the proposals. Therefore formal endangered species consultation under section 7 of the Endangered Species Act was not initiated.

Economic Development Administration (EDA). This agency administers several programs including the Coastal Energy Impact Program, established by Section 308 of the Federal Coastal Zone Management Act of 1972, whereby financial assistance in the form of loans or grants can be provided to local governments whose services might be strained by the projects proposed by the applicants.

Department of Defense

The Army Corps of Engineers (COE). Permitting responsibilities summarized in table 1.6-1, are of three kinds:

> Under Section 10 of the Rivers and Harbors Act of 1899, a permit is required for structures or work in or affecting navigable waters of the United States, the major exception being bridges and causeways which are under Coast Guard jurisdiction.
>
> A permit is required for the discharge of dredged or fill material into waters including adjacent wetlands of the U.S. under Section 404 of the Federal Water Pollution Control Act amendments of 1972.
>
> A permit is required for the transportation of dredged material destined for dumping in ocean waters under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972. This permit process is administered jointly with EPA's permitting responsibility under Section 102 of the same act.

These permits must be obtained by the successful applicant before construction of the submarine piplines. Corps of Engineer's permitting processes includes comment by EPA, the National Marine Fisheries Service, Fish and Wildlife Service and affected state and local governments. These permitting responsibilities in some situations might require detailed environmental reviews in addition to this ES.

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal Reference	Activity Requiring Approval	Form of Action	Applies to:	Remarks
International	International Boundary Commission	United States-Canada Treaty of 1925	Right-of-way within 60 feet of U.S.-Canadian border	Permit Letter of Permission	NEC TMC	
United States	Department of Agriculture Forest Service	43CFR2880	Oil pipeline right-of-way across National Forest lands	Consultation and concurrence with BLM permit	NEC NTPC	
	Department of Defense		Pipeline construction across buried communication cables	Permit	NTPC	
	Air Force		Right-of-way across military reservation	Consultation and concurrence	NTPC	
	Army					
	Navy	43CFR2880	Construction of port facilities	Permit	NTPC NEC TMC	
	Corps of Engineers	33CFR320-329	Pipeline construction	Permit and easements	NTPC NEC TMC	Issues permits for work in and discharge of dredged or fill material into navigable water of the U.S., including pipeline crossings of streams, lakes and wetlands
	Environmental Protection Agency	40CFR112 40CFR52.33 Federal Water Pollution Control Act Amendments of 1972, as amended by the Clean Water Act of 1977	Construction and installation of transfer piping and storage tanks	Permits	NTPC NEC TMC	Has approval authority for industrial sources of air pollution Reviews Spill Prevention, Countermeasures and Control (SPCC) Plans
		33CFR209-120	Disposal of dredge material		NTPC NEC TMC	
		40CFR124-125	Waste water discharge		NTPC NEC TMC	Issues or oversees National Pollutant Discharge Elimination (NPDES) permits
		Clean Air Act of 1977	Air emissions		NTPC NEC TMC	

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal Reference	Activity Requiring Approval	Form of Action	Applies to:	Remarks
United States	Federal Communications Commission	47CFR1	Operation of microwave equipment	Notification	NTPC, TMC, NEC	
			Operation of radio communications	License	NTPC, TMC, NEC	
	Department of the Interior Bureau of Land Management	43CFR2800;2880	Right-of-way for oil pipeline across federal lands	Right-of-way grant	NEC NTPC	Applications are referred to other federal agencies affected by the right-of-way for their consultation and concurrence
	National Park Service	Clean Air Act Amendment of 1977 (P.L. 95-95)	Construction of a major emitting facility near a class I area	Consulting	NTPC TMC	
		36CFR5.7	Pipeline construction across Klondike Gold Rush National Historic Park	Permit	NEC	
	Bureau of Reclamation	43CFR230	Pipeline construction across irrigation districts	Amended easement	NTPC	Permits also required for crossing any Bureau of Reclamation right-of-way
	Bureau of Indian Affairs	25CFR161	Pipeline construction over tribal, individually owned, and tribal-owned lands	Easements	NTPC	Tribal councils can grant or refuse permission to cross tribal lands
	Fish and Wildlife Service	50CFR29.1 43CFR2880	Construction on or across national wildlife refuges or wetland production areas	Crossing agreement contract	NTPC	
			Construction across streams, lakes and wetlands	Consulting	NTPC TMC NEC	Examines applications for Corps of Engineers, Section 10 and 404 permits and recommends modifications prior to approval, or recommends denial

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal Reference	Activity Requiring Approval	Form of Action	Applies to:	Remarks
	Department of Transportation					
	Federal Aviation Administration	DOT 80 Statute 932	Construction on or near airports	Approves construction	NTPC NEC TMC	Regulations prohibit structures above an imaginary line using one foot in 50 from airport center
	Coast Guard	33CFR66, 67, 109, 115, 126, 154, 156 46CFR30-40	Construction in navigable waters, operation of marine facilities, oil transfer operations and shipping	Permits Review/approval Operation approval Vessel inspection	NTPC NEC TMC	Approves all aides to navigation; designate anchorage areas, permits overhead crossings of navigable waters
		43CFR2880	Use of Ediz Hook	Consultation and concurrence	NTPC	The Coast Guard is the agent for federal lands on Ediz Hook (see Map Addendum)
	Office of Pipeline Safety	49CFR191, 192, 193 195	Construction, operation, maintenance, and abandonment of pipeline	Approval	NTPC NEC TMC	Approves construction and material criteria
	Interstate Commerce Commission	49USC1	Railway abandonment	Authorization Notification	NEC	Procedure depends on whether abandonment is temporary or permanent
	Department of Energy					
	Bonneville Power Administration	BPA Act, August 20, 1937 50 Statute 731, Section 2	Pipeline construction across, adjacent to, or overlaying powerline right-of-ways	Joint use permit		
	Federal Energy Regulatory Commission	49CFR subtitle B 1000-1399	Operation of pipeline as a common carrier	Approval for tariff, rate of depreciation, and fair value rate base		

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal Reference	Activity Requiring Approval	Form of Action	Applies to:	Remarks
State and Local	Alaska Department of Environmental Conservation	A.S. 46.03.020 A.S. 46.03.010 A.S. 46.03.100	Actions affecting air and water quality	Permits	NEC	Certifying Agency under Section 401
				Certificates	NEC	Federal Water Pollution Control Act of 1972
	Department of Natural Resources	A.S. 38.35.010 A.S. 38.35.020	Crossing state lands, utilizing tidelands and submerged lands	Permit/Right-of-way	NEC	Any plan for alteration of tidewater or fresh water environment needs approval
	Department of Fish and Game	A.S. 16.05.870 A.S. 16.20.030 A.S. 16.20.230	Construction in anadromous rivers, streams, lakes fish and game refuge/critical habitat areas	Notification	NEC	
	Department of Transportation and Public Utilities	A.S. 19.25.200	Construction along or across highway right-of-way Construction adjacent to an airport	Permit	NEC	
	Skagway Port Authority		Construction and modification of Port of Skagway	Permit	NEC	
	City of Skagway		Building in city limits	Permit	NEC	Compliance with building and zoning ordinances
	Washington Energy Facility Site Evaluation Council	RCW 80.50	Construction and operation of port facilities and pipeline system	Recommends to Governor on certification	NTPC TMC	Council consists of 14 state agencies. Supercedes all state agencies, can preempt local governments (Washington Attorney General's opinion) EFSEC prepares a consistency determinations with local plans and zoning, shoreline master programs, and section 307 of the Coastal Zone Management Act

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal Reference	Activity Requiring Approval	Form of Action	APPLIES to:	Remarks
State and Local	Idaho Department of Lands	Idaho Code Section 58	Construction across state lands and streams	Right-of-ways Permit	NTPC NTPC	Stream beds are state lands
	Department of Water Resources	Idaho Code Title 42 Idaho Code Title 41 Ch. 8	Appropriation of water and stream alterations	Permit	NTPC	
	Department of Transportation	Idaho Code Title 40	Crossing or use of state road right-of-ways	Easements	NTPC	
			Pipe and construction material hauling	Overweight, overlength permits	NTPC	
	Department of Health	Environmental Protection and Health Act 1972, Title 39	Activities affecting air and water quality, waste disposal, use of x-rays	Permits	NTPC	Certifying agency for Corps of Engineers 404 permits under Clean Water Act, P.L. 95-217, Section 401
	Montana Public Service Commission	RCM 1947 Section 8-201 et seq.; Section 72-101 through 205; and Section 93-9905	Request to build a common carrier pipeline and agreement to be bound by Chapter 2, Title 8 RCM	Grant right to construct along, across or under public streams or highways. Right of eminent domain	NTPC	

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal Reference	Activity Requiring Approval	Form of Action	Applies to:	Remarks
State and Local	Montana Department of Natural Resources and Conservation	RCM 1947 Section 89-3501 et seq.	Crossing state forestlands	Right-of-way	NTPC	Responsible for State EIS Issues flood plain and stream crossing permits when local entities do not exercise authority
	Highway Department	RCM 1947 Section 8-203, 32-4403 MAC 18-2. 6A1(2)-S 6020 et seq. MAC 18-2. 14-S14320, 14381	Request to cross highways and streams	Permit	NTPC	
			Pipe and construction material hauling	Overweight, overlength permits	NTPC	
	Department of Health and Environmental Sciences	RCM 1947 Section 69-4801 et seq. Section 69-3901 et. seq.	Construction affecting air and water quality	Permits	NTPC	Involved in stream crossings if turbidity is affected
	Department of State Lands	RCM 1947 81-4, 5, 6, 7, 8, 14, 16, 17, 18	Crossing state lands	Easements	NTPC	
	County commissions	RCM 1947 89-3501 et seq.	Crossing flood plains	Permits	NTPC	
	Conservation districts	RCM 1947 76-109	Stream Crossings	Permit	NTPC	Obtains input from Department of Fish and Game
	North Dakota Public Service commission	North Dakota Cen. Code 49-22	Application for corridor	Certificate	NTPC	Can overrule any local zoning ordinances it considers overly restrictive
			Application for route	Permit	NTPC	
	Water Commission	Section 61.0402; 61.0122, 61.1615; 61.0220, 61.0107	Stream and water crossings and applications to appropriate water	Permit	NTPC	
	Highway Department	Section 24-0139 and 24-0140	Crossing state highways	Permit	NTPC	
			Pipe and construction material hauling	Overweight, overlength permits	NTPC	
	Lands Department	Section 11 Enabling Act. N.D. Cen. Code Section 13 and 54-1701.1	Crossing state land	Permit	NTPC	

TABLE 1.6-1 GOVERNMENTAL AGENCIES HAVING APPROVAL REQUIREMENTS

Government	Responsible Agency or Subdivision	Legal References	Activity Requiring Approval	Form of Action	Applies to:	Remarks
State and Local	North Dakota Department of Health	Ch. 23-25; 23-20.1 23-01; 61.28; 23-29.01; 23-01.07	Actions affecting air and water quality and solid waste	Permits	NTPC	
	Counties and townships		Crossing other than state roads	Permits	NTPC	
			Actions impacting zoning ordinances	Certificate of compliance	NTPC	
	Minnesota Energy Agency	Minn. Statute 116H.13 and agency rules Ch. 10	Application for pipeline project	Certification of need	NTPC	This action necessary before other state actions can proceed
	Department of Natural Resources	Minn. Statute 11.6D and 117.49	Pipeline proposal	Write EIS	NTPC	May adopt federal ES and make state additions. If project accepted, approves right of eminent domain
				Approval of eminent domain	NTPC	
				Permits for water crossings	NTPC	
				Right-of-ways	NTPC	
	Environmental Quality Board	Minn. Statute Ch. 116C and D	Presentation of EIS	Approval for compliance with state Environmental Policy Act	NTPC	Also certifies water crossing permits given by Corps of Engineers
	Pollution Agency	Minn. Statute Ch. 115 and 116	Pipeline construction affecting water quality and waste disposal	Permits for test water discharge and tank storage	NTPC	
	Department of Transportation	Minn. Statute 161.45	Crossing state and interstate roads	Permits	NTPC	
			Pipe and construction material hauling	Overweight overlength permits	NTPC	
	Counties	Minn. Statute 161.45	Crossing other than state roads	Variable	NTPC	

The NTPC port facility on Ediz Hook would require relocation of the offloading pier used for the $5.7 million Corps Beach Erosion Control Project. The project was essentially completed in fall of 1978. The city of Port Angeles, as the local sponsor, shared in the construction and annual maintenance costs.

Department of Energy (DOE). Under Title V of the Public Utilities Regulatory Policy Act (PURPA), DOE provides essential economic and political analysis of the proposals. About 135 miles of the proposed NTPC pipeline would follow Bonneville Power Administrations (BPA) transmission corridor right-of-way. TMC's proposed pipeline would follow approximately 28 miles of BPA right-of-way. It's BPA's policy to allow joint use of their right-of-way when it is technically feasible and desirable in reducing environmental impacts.

Department of the Interior

Bureau of Land Management (BLM). In issuing a right-of-way grant across federal lands, BLM consults with each affected land management agency. In addition, BLM is required under section 106 of the National Historic Preservation Act of 1966 (PL 89-665), to ensure consideration of prehistoric and historic cultural resources through consultations with the Advisory Council on Historic Preservation. BLM has initiated the process to establish a Memorandum of Agreement with the Council and each affected State Historic Preservation Officer to provide for the identification, evaluation, protection, and preservation of cultural resources. The U.S. Geological Survey is consulted regarding mineral, geothermal and water resources. Other agencies are consulted as indicated elsewhere in this section. BLM issued rights-of-way would pertain to the NTPC and NEC proposals.

Bureau of Indian Affairs (BIA). The NTPC proposed pipeline route would cross trust lands allotted to individuals and tribal trust lands. BIA and Tribal Council approval is required for easements across tribal trust lands.

Bureau of Reclamation. The NTPC proposed pipeline route would cross the Yakima and Columbia Basin Reclamation Projects in Washington and the Frenchtown and Canyon Ferry Projects in Montana. Bureau of Reclamation would require permit stipulations to ensure that the pipeline would not adversely affect these projects.

Fish and Wildlife Service (FWS). In addition to the responsibilities summarized in Table 1.6-1, FWS administers the Endangered Species Act of 1973, and has been consulted by BLM and Corps of Engineers regarding threatened or endangered species of non-marine fish, wildlife and plants. Six species were considered in the consultation: gray wolf, grizzly bear, whooping crane, bald eagle, peregrine falcon, and black footed ferret.

Heritage Conservation and Recreation Service. The agency is responsible for insuring protection to sites listed in the National Register of Historic Places which may lie in the route of the proposed pipeline. The agency also administers and implements a natural areas program including the National Registry of Natural Landmarks, and serves as the primary coordinating agency for outdoor recreation at federal, state and local levels.

Department of Transportation

Coast Guard. Under Title 46 of the U.S. Code and the Ports and Waterways Safety Act of 1972 the Coast Guard has regulatory authority over the design, construction, maintenance and manning of oil tankers; navigational access of those tankers to ports; and response to oil spills. The Coast Guard has a boarding program to prevent foreign tankers not meeting certain standards from using U.S. ports.

Effective June 1, 1981, crude oil tankers of 70,000 dwt or more will be required to have an inert gas system designed to prevent tanker explosions. Effective June 1, 1983, this requirement will be extended to tankers of 20,000 dwt or more. The Coast Guard is further requiring that crude oil tankers of 40,000 dwt and above be retrofitted with either segregated ballast or a crude oil washing system. These requirements will apply to tankers transporting Alaska north slope oil from Valdez, Alaska to the proposed ports.

In cooperation with Canada the Coast Guard will, by 1981, extend the area covered by mandatory Vessel Traffic Service (VTS) from Puget Sound to include the Strait of Juan de Fuca. VTS consists of separation lanes, bridge to bridge communications, vessel movement reporting and radar surveillance advisories. Establishing VTS for the approach to Skagway has not been proposed.

Coast Guard regulatory authority would be concerned with port safety, national defense, and pollution prevention of the proposed port facility. An operations manual detailing all procedures to be used must be approved by the Coast Guard before the port could operate. In conjunction with Environmental Protection Agency, Coast Guard is responsible for reviewing and approving contingency plans.

The Coast Guard, along with EPA, has on-scene authority for removing spilled oil if not satisfactorily removed by the spiller. Vessels or facilities that spill oil have a legal responsibility to report each spill to the Coast Guard.

Those portions of the NTPC port facility located on Ediz Hook would occupy federal land administered by the Coast Guard including a portion of the Port Angeles Air Rescue Station. In July 1979, the Coast Guard commenced a $2.5 million rehabilitation project at the Air Station which includes improvements to the aircraft hangar, remodeling barracks, construction of new buildings and demolition of excess and obsolete buildings. The Air Station could be impacted by the port facility proposed by NTPC.

Federal Aviation Administration. Construction of the NTPC port facility on Ediz Hook would require relocation of the Vertical Omnirange (VOR) station. VOR stations serve as an aid to air navigation. The NEC proposal would involve construction adjacent to the Skagway airport.

Environmental Protection Agency (EPA). In addition to its permitting responsibilities and joint responsibilities with the Coast Guard regarding oil spills and contingency plans, EPA would have overall responsibility to ensure that the proposals would be planned, constructed, and operated in accordance with the National Environmental Policy Act of 1969, the Clean Air Act of 1970, and the Clean Water Act of 1972 as amended.

State and Local Governments

The status of local land use plans, zoning and shoreline management regulations in each of the affected states is shown in table 1.6-2. Where identified, significant inconsistencies with these plans and regulations and the resultant impacts are discussed in the Land Use sections of Chapters 3, 8, and 9.

TABLE 1.6-2 STATUS OF LOCAL PLANNING AND ZONING

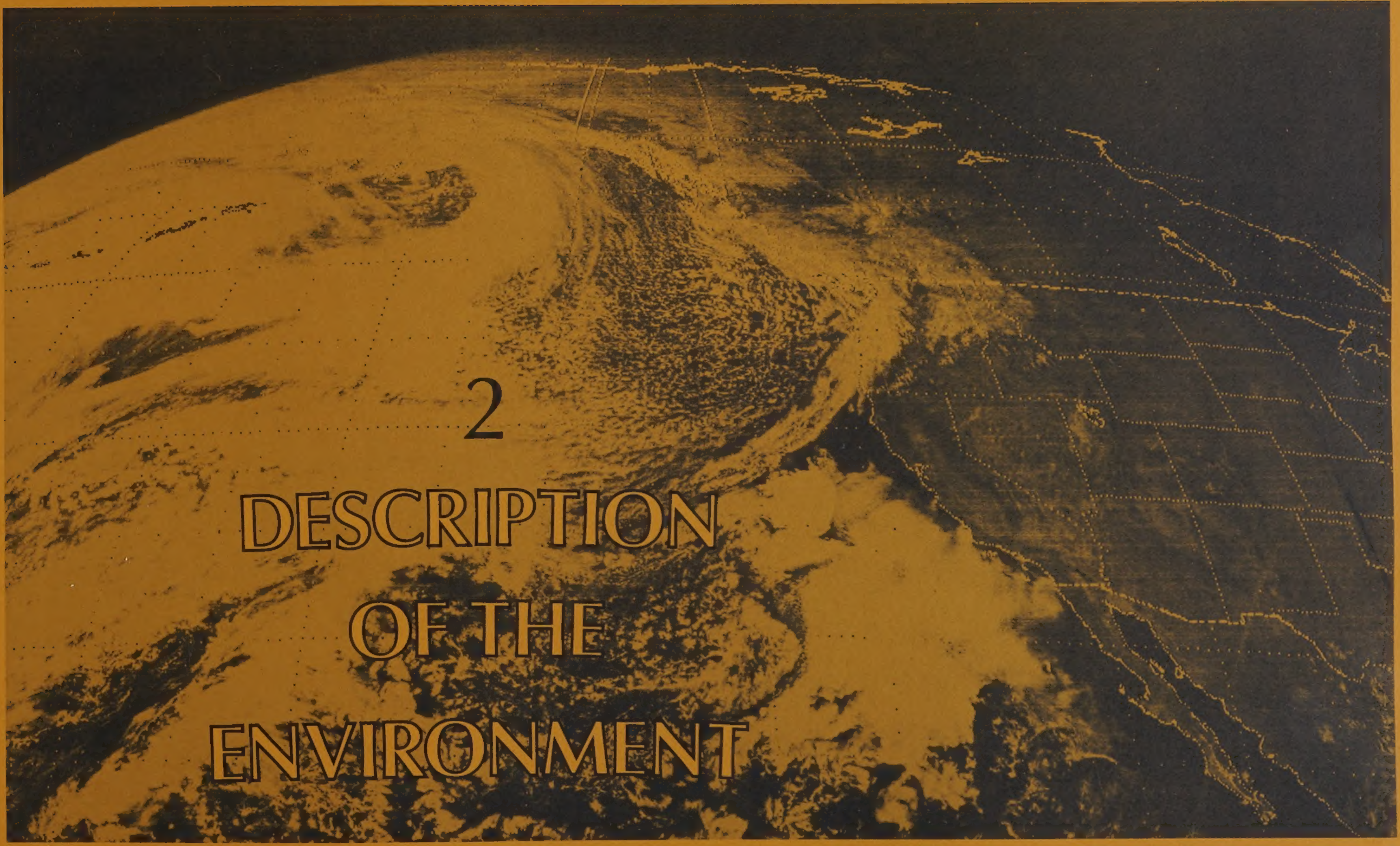
Proposal	State and County	Comprehensive Plan	Zoning Ordinance	Other Applicable Regulations or Ordinance
NEC	Alaska	Draft, Haines-Skagway area	City of Skagway	Coastal Energy Impact Program Being Developed
	Washington			
NTPC/TMC	Clallam	Yes	1/	Shoreline Master Program
NTPC/TMC	Jefferson	Yes	None	Shoreline Master Program
NTPC/TMC	Island	County; city of Oak Harbor	County; city of Oak Harbor	Shoreline Master Program
NTPC/TMC	Snohomish	County; city of Stanwood	County; city of Stanwood	Shoreline Master Program
TMC	Skagit	Yes	Yes	Shoreline Master Program
TMC	Whatcom	Yes	Yes	Shoreline Master Program
NTPC	King	Yes	Yes	Shoreline Master Program
	Kittitas	Yes	Yes	Shoreline Master Program
	Grant	Yes	Yes	Shoreline Master Program
	Lincoln	Yes	Yes	Shoreline Master Program
	Adams	Yes	Yes	
	Spokane	Yes; city of Spokane only at present	Yes; city of Spokane only at present	Shoreline Master Program
	Idaho			
	Benewah	Draft plan	None	
	Kootenai	Yes	Yes	
	Shoshone	Yes	None	
	Montana			
	Sanders	None	None	
	Missoula	Yes	None	
	Powell	Yes	None	
	Lewis & Clark	City/county plan for Helena area	Yes, in Helena area	Sedimentation regulations
	Jefferson	None	None	
	Broadwater	None	None	
	Meagher	Yes	None	
	Wheatland	None	None	
	Golden Valley	None	None	
	Musselshell	Yes	None	
	Fergus	In progress	None	
	Petroleum	None	None	
	Garfield	None	None	
	McCone	In progress	None	
	Dawson	None	None	
	Richland	None	None	
	Roosevelt	None	None	
NTPC	North Dakota			
	Williams	Draft plan	Yes, in some townships	
	Mountrail	Yes	Being prepared	
	Ward	Yes	Yes	
	McHenry	None	None	
	Pierce	None for county; city of Rugby plan	County; city of Rugby	
	Benson	None	None	
	Ramsey	Yes	Yes	
	Nelson	County; cities of Lakota, Petersburg, and Michigan	County; cities of Lakota, Petersburg and Michigan	
	Grand Forks	Draft Plan	Yes	
	Minnesota			
	Polk	Yes	Yes	Shoreline Management Ordinance
	Red Lake	No	No	Shoreline Management Ordinance
	Clearwater	Yes	No	Shoreline Management Ordinance

Sources: Washington - NTPC 1978, pers. comm.
Idaho - personal communications Panhandle Area Council 1978
Montana - Montana Department of Community Affairs 1978
North Dakota - North Dakota State Planning Division 1978
Minnesota - Personal Communications 1978
Alaska - Personal Communications

1/ Text of Ordinance voided by State Supreme Court ruling in Byer vs. Board of Clallam County Commissioners, 84WN.2d796 (1974)

Alaska. The NEC proposal, if approved, would require compliance with provisions of the Alaska and the Skagway Coastal Zone Management Programs likely to be implemented in the near future. Joint plans by the city and state involve expansion and/or modification of the existing ferry boat terminal in Skagway harbor and improvements to streets in Skagway. The city of Skagway operates a 75 berth small boat harbor scheduled for relocation and mooring float expansion. Construction of the NEC port and pipeline facilities would interact with these planned harbor and street improvements through increased traffic congestion and deterioration of streets.

Washington. NTPC and TMC must file applications with the Energy Facility Site Evaluation Council (EFSEC), as indicated in table 1.6-1. Although EFSEC can preempt local regulations or state laws such as the Shoreline Management Act and local



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CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT
(Proposal of the Northern Tier Pipeline Company)

2.1 EXISTING ENVIRONMENT

This chapter describes the environment as it exists today, that is, without any effects that might result from implementation of the crude oil transportation system as proposed by Northern Tier Pipeline Company (NTPC). Environmental components are described to the degree of detail considered necessary for identification and quantification of significant impacts anticipated if the proposal were implemented. Environmental factors not significantly affected are not described in detail.

PORT AND ONSHORE STORAGE FACILITIES

CLIMATE

General Climate

Port Angeles has a maritime climate with mild winters and cool summers. Rain and cloudiness are common. The Olympic Mountains just south of Port Angeles create a "rain shadow"; average annual rainfall is 24.6 inches.

The eastern Pacific high pressure zone and the Aleutian low are the dominant influences on Port Angeles weather. In fall, the high pressure zone moves southward, allowing more Pacific storms to move through the area. During late spring, the high pressure zone moves northward forcing Pacific storms along a more northerly track, and creating dry, stable weather. Average monthly rainfall reaches a maximum in December of 4.4 inches, and a minimum in July of 0.5 inches. Maximum 24-hour rainfall observed was 3.30 inches. Snowfall averages 8.5 inches annually.

Average maximum temperature is 44° F in January and average minimum is 34° F. In July, average maximum reaches 65° F while the average minimum is 51° F. The highest maximum temperature recorded was 93° F; extreme minimum temperature recorded was 7° F. The growing season averages 240 days.

The average relative humidity is about 86 percent in morning and 77 percent in afternoon.

Fog at Port Angeles is most common during late summer and early fall. Heavy fog (visibility of 1/4 mile or less) occurs 10 percent of the time in September. Heavy fog occurs less than 1 percent of the time during spring. Frequency of visibility of 1 mile or less varies from 0.4 percent of the time in April to 12.5 percent of the time in October.

While predominant wind direction is westerly, easterly winds are common in the winter. The average wind speed is about 10 miles per hour (mph). Average wind speeds are highest in the summer--14 mph in July. Lowest average speeds occur in the fall--7 mph in October. Severe weather such as tornadoes, heavy thunderstorms, and hailstorms are rare. Strong easterly winds are associated with an approaching Pacific storm. After storm passage, strong westerly winds can occur. Wind speeds greater than 28 mph occur about 0.7 percent of the time; winds greater than 39 mph occur less than 0.1 percent of the time. The highest 1-hour average wind speed recorded at Port Angeles was 58 mph.

Dispersion Potential

Dispersion potential is a measure of the ability of the atmosphere to dilute pollution. Parameters that determine dispersion potential include wind speed, mixing height, and temperature change with height.

Mixing height is the height to which pollutants can be dispersed. The greater the mixing height, the larger the volume through which pollutants would be mixed, and the lower the pollutant concentration. Temperature change, with height can cause intense atmospheric mixing. An increase of temperature with height (or an inversion) greatly inhibits mixing and leads to rapid pollution buildup in the lower atmosphere.

Frequency distribution of wind direction was observed at the U.S. Coast Guard Station on Ediz Hook (fig. 2.1-1). Winds blow from directions between northwest and southwest about 58 percent of the time and winds from northerly directions occur about 13 percent of the time.

According to atmospheric stability data, neutral conditions occur over Port Angeles about 63 percent of the time. Neutral conditions, normally associated with moderate wind speeds and extensive cloud cover, indicate good mixing. Unstable conditions, which represent more intense mixing, occur about 15 percent of the time and normally occur during days with moderate sunshine and light winds. Stable conditions, least favorable for dispersion, occur about 22 percent of the time, usually at night when the lowest atmospheric layer cools off fastest. Winds associated with stable conditions are very light. In the Port Angeles area stable conditions occur with winds flowing from the Olympic Mountains, or when cool air blows in from the ocean in summer.

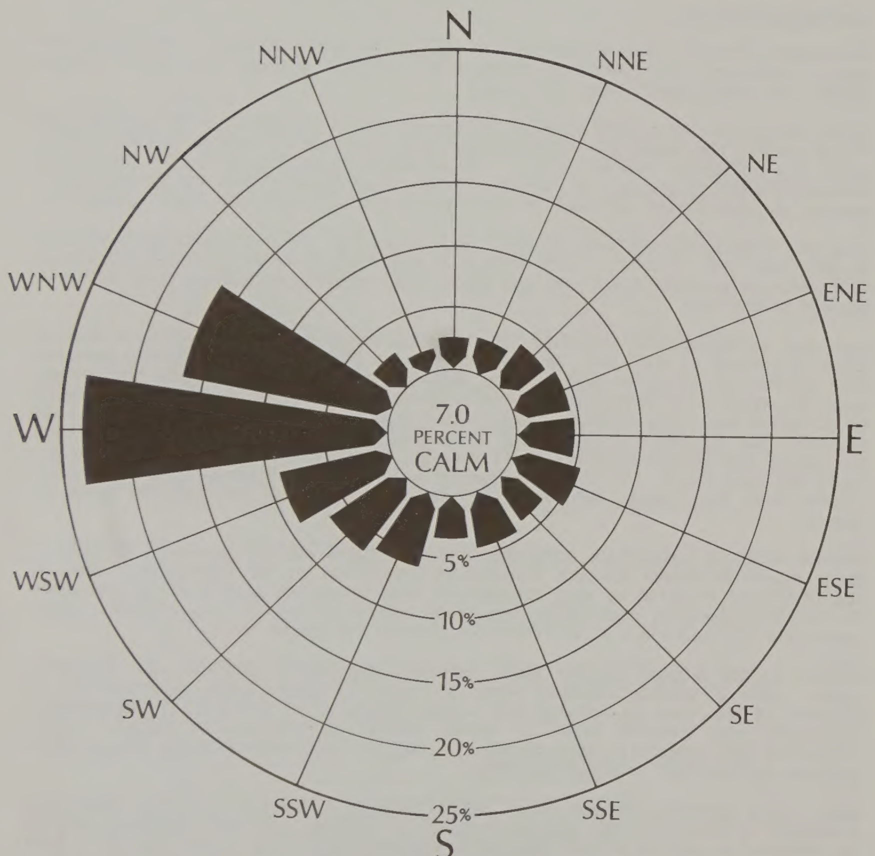
Limited vertical temperature soundings have been taken at Port Angeles (EG&G 1973). These soundings showed frequent temperature inversions in the summertime. Some of the inversions measured by EG&G extended to heights greater than 1,000 meters above the ground, indicating restrictive dispersion conditions through a deep layer. These summertime inversions are a result of cool, marine air masses.

Seattle is the nearest station where vertical temperature soundings are routinely taken. Data at Seattle indicate inversions exist at ground level an average of 52 percent of the time in morning and about 6 percent of the time in afternoon. Inversions also commonly exist at higher levels, particularly in summer. These inversions are typically found at about 1,000 to 1,500 meters above ground level (Science Applications Incorporated 1978).

Table 2.1-1 provides average daily mixing heights based on vertical temperature soundings at Seattle. The Seattle station is subject to urban influences but is not affected as greatly as Port Angeles by maritime conditions. Port Angeles is also affected by the Olympic Mountains. Expected mixing heights at Port Angeles should be somewhat lower than at Seattle, particularly in summer. This is supported by mixing heights calculated at Quillayute, located on the Pacific shore of the Olympic Peninsula. Mean maximum mixing heights there ranged from 472 meters in January to 1,079 meters in May (EG&G 1973). These are generally lower values than at Seattle.

WIND ROSE

Frequency distribution of wind direction*, at Port Angeles



Numerical value is in percent of time.

*Based on hourly wind data for years 1948 through 1952.

Figure 2.1-1

Source: U.S. Coast Guard

Dispersion conditions are generally better in afternoon than in morning. Best conditions occur in spring and worst in fall.

TABLE 2.1-1 AVERAGE MIXING HEIGHT IN THE SEATTLE AREA
(In Meters)

	Morning	Afternoon
Winter	800	700
Spring	850	1500
Summer	600	1300
Fall	600	900
Annual	700	1100

Source: Holzworth 1972

AIR QUALITY

Regulation of air quality in the Port Angeles area falls under jurisdiction of the Olympic Air Pollution Control Authority, a six-county regional control agency under Washington State Department of Ecology with authority to set emission regulations and air quality standards and to assess penalties for violations.

Standards for air quality have been established by the federal government, the state, and by the Olympic Air Pollution Control Authority. Primary standards are designed to protect human health. Secondary standards are designed to protect human welfare and property. All the standards that apply to the proposed port and onshore storage facilities are listed in table 2.1-2.

Port Angeles is located in the Olympic-Northwest Washington Air Quality Control Region. Air quality control regions (AQCRs) are geographic areas with common air quality problems, designated for regional control strategies.

Areas with potential to exceed national ambient air quality standards (NAAQS) were designated air quality maintenance areas (AQMAs). With the passage of the 1977 Amendments to the Clean Air Act, the concept of AQMA was redefined in an attempt to emphasize meteorological and topographical features rather than political boundaries. The 1977 amendments required the Environmental Protection Agency (EPA) to establish nonattainment areas for specific pollutants. A portion of Port Angeles is a nonattainment area for total suspended particulates, exceeding standards set under the Clean Air Act.

The Prevention of Significant Deterioration (PSD) regulations apply to all pollutants regulated under the Clean Air Act of 1977. These regulations include establishment of different class areas limiting future air quality degradation. Presently, maximum allowable incremental degradation is established for sulfur dioxide and total suspended particulates. Currently, only sulfur dioxide and particulate concentrations are regulated. Increments for the three different classes are given in table 2.1-3.

TABLE 2.1-2 AMBIENT AIR QUALITY STANDARDS
APPLICABLE TO THE PORT ANGELES AREA
Micrograms Per Cubic Meter (ug/m3)

Pollutant	National		Washington State
	Primary	Secondary	
Sulfur Dioxide			
Annual average1/	80		53
24-hour average2/	365		260
3-hour average2/		1,300	
1-hour average2/			1,048
1-hour average3/			655
Suspended Particulates			
Annual geometric avg1/	75	60	60
24-hour average2/	260	150	150
Carbon Monoxide4/			
3-hour average2/	10	10	10
1-hour average2/	40	40	40
Ozone			
1-hour average2/	240	240	1605/
Non methane Hydrocarbons6/			
3-hour average2/7/	160	160	1608/
Nitrogen Dioxide			
Annual Average1/	100	100	100
Lead			
Quarterly Average	1.5	1.5	

Source: Science Application Inc. (SAI) 1978
1/ Never to be exceeded.
2/ Not to be exceeded more than once a year.
3/ Not to be exceeded more than twice in 7 days.
4/ Milligrams per cubic meter.
5/ 10 a.m. to 4 p.m., April 1 through October 31.
6/ This standard is to be used as a guide in devising implementation plans to achieve the ozone standard.
7/ 6 a.m. to 9 a.m.
8/ April 1 through October 31.

TABLE 2.1-3 MAXIMUM ALLOWABLE PREVENTION OF SIGNIFICANT DETERIORATION INCREMENTS
Micrograms Per Cubic Meter (ug/m^3)

Pollutant	Class I	Class II	Class III
Sulfur dioxide			
Annual	2	20	40
24-hour1/	5	91	182
3-hour1/	25	512	700
Particulates			
Annual1/	5	19	37
24-hour1/	10	37	75

Source: Federal Register, vol 42, no. 212, November 3, 1977
1/ Not to be exceeded more than once per year.

When PSD regulations were first promulgated in 1975, all areas were Class II. The Clean Air Act Amendments of 1977 established all national parks over 6,000 acres, national memorial parks over 5,000 acres, and national wilderness areas over 5,000 acres as mandatory Class I. Procedures now allow the states to redesignate most areas. Mandatory Class I areas, however, cannot be reclassified. In addition, national monuments, primitive areas, preserves, recreation areas, wild and scenic rivers, and similar areas can be redesignated to Class I. In 1976, the boundary of Olympic National Park was modified to include the 517-acre Heart O'the Hills parkway corridor, which extends from behind the visitor center to Heart O'the Hills Ranger Station. This area is a part of the park and has Class I air quality standards. The closest boundary of the park is within 3 miles of the proposed port. The park boundary is shown in the Map Addendum. All areas adjacent to the Olympic National Park are classified Class II.

Industrial sources of air pollution in Port Angeles are two pulp mills and a plywood plant. Emissions from these plants--more than half of the total emissions of particulates, sulfur dioxide, and nitrogen oxides for Clallam County--are listed in table 2.1-4.

TABLE 2.1-4 MAJOR SOURCES OF INDUSTRIAL AIR POLLUTANT EMISSIONS
IN THE PORT ANGELES AREA FOR 1976
(Tons per year)

Plant	Particulates	SO_2	NO_x
Peninsula Plywood	180	0	94
ITT Rayonier, Inc.	785	2,825	1,630
Crown Zellerbach	916	875	921

Sources: Olympic Air Pollution Control Authority 1978; ITT Rayonier 1978

Total suspended particulates (TSP) have been monitored in Port Angeles since 1969. Recent data on TSP are available for three different locations (see Map Addendum). Data from 1976 through 1978 are summarized in table 2.1-5. At the City Light Station, located in downtown, annual state and federal secondary standards of 60 ug/m3 were exceeded in each of the three years. The 24-hour federal and state standards of 150 ug/m3 were exceeded five times each in 1976 and 1977, and seven times in 1978. No violations were recorded at the other two sites.

TABLE 2.1-5 OBSERVED TOTAL SUSPENDED PARTICULATE CONCENTRATIONS (μg/m3) FOR PORT ANGELES

	1976		1977		1978	
	Annual Geometric Mean	Max. 24 hr.	Annual Geometric Mean	Max. 24 hr.	Annual Geometric Mean	Max. 24 hr.
Hospital	42	111	47	104	37	76
Pool Site	40	112	44	160	43	97
City Light Station	72	217	66	275	67	252

Source: Washington Department of Ecology 1979

Because of violations of the particulate standard in the downtown area, a portion of the commercial district of Port Angeles has been designated a nonattainment area (see Map Addendum). Violations have been attributed to dust from local log storage and log trucking operations.

Sulfur dioxide in Port Angeles has been monitored by Washington Department of Ecology since 1974. However, monitoring prior to December 1977 was voided due to instrumentation problems. Data are now available for two sites. One is located at Third and Chestnut, in a residential area in the eastern part of Port Angeles, about half a mile from the ITT plant. The other one is located at the City Light Station, in downtown Port Angeles.

The results of monitoring conducted at these two sites are shown in table 2.1-6. At the Third and Chestnut site, the state of Washington 1-hour standard of 1,048 ug/m3 was violated 13 times, and the 24-hour standard of 260 ug/m3 was violated 6 times. The federal primary 24-hour standard of 365 ug/m3 was exceeded once. Concentrations at the downtown site were considerably lower and no violations were recorded there.

The Olympic Air Pollution Control Authority is presently reviewing the data in order to determine the attainment status for sulfur dioxide.

TABLE 2.1-6 OBSERVED SULFUR DIOXIDE CONCENTRATIONS (μg/m^3) IN PORT ANGELES FOR 1978

	Third & Chestnut a/	City Light Station b/
Maximum 24-hr. average	390	78
Maximum 3-hr. average	1144	416
Maximum 1-hr. average	1768	572
Average hourly	77	26

Source: Washington State Department of Ecology 1979
a/ Based on 78 days of observations.
b/ Based on 202 days of observations.

Modeling was used to estimate existing sulfur dioxide concentrations in the Port Angeles area (SAI 1978). The highest annual average concentration was 28 ug/m^3, found about a mile east of the ITT Rayonier plant. This concentration is within the state standard of 53 ug/m^3. The maximum 24-hour concentration was 237 ug/m^3, within the state standard of 260 ug/m^3.

No monitoring data are available at this time on nitrogen oxides, carbon monoxide, or ozone in the Port Angeles area. Modeling for existing industrial sources in Port Angeles resulted in an annual average concentration of nitrogen oxides of 5 ug/m^3. This consists of nitric oxide and its byproduct, nitrogen dioxide. The federal standard of 100 ug/m^3 for the annual average applies only to nitrogen dioxide. Thus, the calculated concentration is well within the standard. Ozone measurements have been taken by the Department of Ecology in Sequim, about 15 miles east of Port Angeles. The highest 1-hour average observed in a 3-month period in 1977 was 0.05 parts per million (ppm), which is within the national standard of 0.12 ppm.

No air quality data exist at the present time within the Olympic National Park. Modeling calculations using present emission data indicate an annual average sulfur dioxide concentration of about 5 ug/m^3 at park headquarters and 1 ug/m^3 at the Heart O'The Hills Ranger Station. Modeling also indicated a maximum 24-hour concentration of about 45 ug/m^3 near park headquarters and 20 ug/m^3 at the ranger station. However, due to inherent uncertainties in modeling, these figures need verification with actual measurement.

There is presently no data on visibility for Port Angeles or the Olympic National Park. Nephelometer data, from which visual range can be calculated, are presently being collected by NTPC at the Olympic National Park Headquarters and at Lake Dawn. Visibility in the Port Angeles area is effected by several industrial sources. Several plumes are usually visible and haze over the area is observed during light wind conditions. However, at present there are no quantitative data available on visual range. Stack plumes and haze are also visible from several viewpoints within the Olympic National Park. The view from these points is also frequently obstructed by clouds or precipitation.

In July 1978, a meteorological and air quality monitoring network was established in Port Angeles and in the Olympic National Park by Environmental Research and Technology, Inc. Air quality monitoring includes sulfur dioxide, nitrogen oxides, particulates, hydrocarbons, ozone, and visibility. No data from this network is available at this time.

NOISE

A discussion of the existing noise environment includes identification of noise sensitive receptors, existing noise sources, existing noise levels, and topography and barriers that influence sound dispersion.

Noise levels, as they impact the human environment are commonly expressed in terms of an A-weighted decibel scale (dBA). Typical noise sensitive receptors are residential areas, schools, hospitals, recreational facilities, and other areas where relatively low noise levels are important in protecting public health and welfare.

Some areas are much more noise sensitive than others. For example, in residential areas noise levels required to maintain public health and welfare are lower than in commercial or industrial areas. Duration, intensity, and time of day are also important.

To evaluate effects of noise levels, a time-averaged equivalent A-weighted noise level (L_{eq}) is defined. Daytime equivalent noise level (L_d) is that typically observed in the hours between 7 a.m. and 10 p.m. A nighttime equivalent noise level (L_n) is that typically observed between the hours of 10 p.m. and 7 a.m. A day/night equivalent noise level (L_{dn}) is defined as the energy average of the day and night levels with 10 dBA added to the nighttime reading before averaging.

The Environmental Protection Agency has established guidelines for community noise levels for protection of public health and welfare (EPA 1974). According to those guidelines, day/night equivalent outdoor noise levels below 55 dBA will not degrade public health and welfare. The EPA guidelines are shown on table 2.1-7.

TABLE 2.1-7 SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

Effect	Level	Area
Hearing loss	$L_{eq(24)} \leq 70$ dBA 1/	All areas.
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dBA	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} \leq 55$ dBA	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dBA	Indoor residential areas.
	$L_{eq(24)} \leq 45$ dBA	Other indoor areas with human activities such as schools, etc.

Source: Adapted from Environmental Protection Agency 1974
1/ $L_{eq}(24)$ is equivalent noise level averaged over 24 hours.
$\leq$ indicates less than.

The Washington Administrative Code (WAC 173-60-040), establishes the maximum permissible environmental noise level in a residential zone from noise sources in an industrial zone at 60 dBA during the day and 50 dBA at night. However, noise originating from temporary construction activities between 7 a.m. and 10 p.m. is specifically exempted (WAC 173-60-050 (3)(a)).

Ambient noise measurements have been taken at six different locations in Port Angeles by Environmental Research and Technology, Inc. (NTPC 1978). The Map Addendum shows the locations of sites measured and land use patterns of Port Angeles. These sites are located 500 to 11,000 feet from the proposed berthing facility and chosen to represent typical noise sensitive receptors.

The proposed port is separated from Port Angeles by approximately 1.5 miles of open water. Industrial operations are primarily located along the water front. The major portion of the city and its residential areas are situated beyond a 100 to 200 foot bluff. Representative noise levels, averaged over a 20-minute period, are summarized in table 2.1-8.

As shown in table 2.1-8, values range from 54 to 63 dBA during the day and 46 to 59 dBA at night. Noise levels were attributed to industrial activities at the pulp mills, automobile traffic, and boating operations. The observed daytime noise levels at Port Angeles are moderate, typical of a semicommercial area. Nighttime readings are low to moderate.

Ambient noise levels were also measured at three locations in the vicinity of the proposed onshore storage facility. (See Map Addendum.) Noise sensitive receptors consist of small groups of single family residences. There are approximately 10 houses from 500 to 2,000 feet east of the property line, and about 20 houses approximately 4,000 feet southeast of the proposed onshore storage facility. Directly to the west is a new subdivision with existing and planned units at distances ranging from 200 to 4,000 feet (NTPC 1978). The proposed onshore storage facility would be located on a bluff about 100 feet high consisting of flat areas and gently rolling hills. The measured noise levels are given in table 2.1-9. Daytime equivalent noise levels ranged from 32 to 62 dBA; nighttime readings, from 30 to 39 dBA. These levels are typical of quiet residential or rural areas, and are attributed to traffic noise.

TOPOGRAPHY AND GEOLOGY

Topography

The proposed port and onshore storage facilities would be located along the northern coastline of the Olympic Peninsula in the foothills of the Olympic Mountains. This rugged, northward trending mountain range comprises the bulk of the peninsula.

Port Angeles harbor, the site of the port facility, is a natural deep water port bordered on the south and southwest by a prominent coastal bluff 50 feet high, and on the north and northwest by Ediz Hook, a long, low depositional spit that shelters the harbor. The harbor bottom is asymmetrical, with a moderately steep (18 percent slope) north side and a gentle (generally less than 5 percent slope) south slope; the deepest portion, 192 feet, is within 1,500 feet of the south shore of Ediz Hook.

TABLE 2.1-8 SUMMARY OF OBSERVED NOISE LEVELS AT PORT ANGELES

Location	Type of Noise Sensitive Receptor	Date	Hour	L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{max}	L_{eq}	L_d	L_n	L_{dn}
1.	Recreation area	2/15/78	0601	45	45	46	47	48	50	47		47	60
			1435	48	49	54	62	69	75	60	60		
			2255	41	43	45	47	49	52	46		46	60
		2/16/78	1200	51	53	55	63	71	77	61	61		
2.	Park	2/15/78	0700	42	43	45	48	59	65	49		49	57
			1405	49	50	52	55	60	64	54	54		
			2325	49	50	52	55	59	59	53		53	60
3.	Boat launch	2/15/78	1345	53	54	58	62	70	75	61	61		
			2225	45	47	50	56	65	72	55		55	63
4.	Viewpoint	2/15/78	1220	52	55	60	65	72	76	63	63		
		2/16/78	0130	46	47	50	58	66	70	56		56	64
5.	Park	2/15/78	1300	53	54	56	61	71	75	60	60		
		2/16/78	0100	43	44	46	50	62	64	50		50	60
			1115	50	53	57	63	68	69	60	60		
6 1/	Hospital	2/15/78	1155	56	57	58	60	76	81	63	63		
		2/16/78	0000	55	56	57	60	61	61	59		59	66
6A. 2/	Hospital	2/16/78	0020	45	46	49	51	55	57	50		50	60
6B. 3/		2/16/78	1315	49	50	51	56	58	59	54	54		

SYMBOL	DEFINITION
L_{99}	The sound level exceeded 99 percent of the time during the measurement period.
L_{90}	The sound level exceeded 90 percent of the time during the measurement period; often used to represent the "residual" sound level.
L_{50}	The sound level exceeded 50 percent of the time during the measurement period; used to represent the "median" sound level.
L_{10}	The sound level exceeded 10 percent of the time during the measurement period.

SYMBOL	DEFINITION
L_1	The sound level exceeded 1 percent of the time during the measurement period.
L_{max}	Maximum observed sound level during the measurement period.
L_{eq}	The equivalent steady sound level which provides an equal amount of acoustic energy as the time varying sound.
L_d	The average sound level, L_{eq}, for the daytime period (0700-2200) only.
L_n	The average sound level, L_{eq}, for the nighttime period (2200-0700) only.
L_{dn}	The day/night average sound level with a 10 db correction factor is added to the nighttime average sound level.

Source: NTPC 1978

1/ At northeast corner of hospital property nearest ITT Rayonier Plant

2/ In southwest parking lot area of hospital property; ITT Plant blocked from view

3/ At southwest corner of hospital property

Note: For site locations see Map Addendum

TABLE 2.1-9 SUMMARY OF OBSERVED NOISE LEVELS AT PROPOSED ONSHORE STORAGE FACILITY

Location	Type of Noise Sensitive Receptor	Date	Hour	L_{99}	L_{90}	L_{50}	L_{10}	L_1	L_{max}	L_{eq}	L_d	L_n	L_{dn}
T 1.	Residence	2/15/78	0920	35	36	41	50	58	60	48	48		
			1700	33	33	37	47	54	55	44	44		
		2/16/78	0250	31	32	32	34	43	44	34		34	44
T 2.	Residence	2/15/78	0955	36	38	45	55	67	75	56	56		
			1727	34	37	43	56	70	87	62	62		
		2/16/78	0310	32	32	33	35	46	57	39		39	60
T 3.	Northwest boundary of proposed on-shore storage facility	2/15/78	1045	33	33	35	38	41	44	36	36		
			1800	29	29	31	34	39	40	32	32		
		2/16/78	0345	28	28	29	30	33	38	30		30	37

Source: NTPC 1978

Note: For site locations see Map Addendum
See table 2.1-8 for definition of symbols

Green Point, the site of the proposed onshore storage facility, is a prominent headland about 6 miles east of Port Angeles, composed of rolling hills and a series of terraces that terminate in a 100- to 125-foot coastal bluff adjacent to the Strait of Juan de Fuca.

Geology

Surficial geologic deposits found at the port and onshore storage facilities are thick (often exceeding 300 feet), and consist of Quaternary glacial, glaciomarine, and beach deposits, along with some artifical fill (including riprap). They are underlain by northward dipping, Lower Tertiary (Eocene) sedimentary and volcanic rocks (see table 2.1-10). Data concerning the harbor are incomplete, but available information indicates a deposit of dense sand and gravel overlain by medium-dense to very loose sand, silt, bay mud, assorted logs, and other debris (Hart-Crowser 1976; Shannon & Wilson 1978). (See Map Addendum.)

TABLE 2.1-10 GEOLOGIC TIME SCALE

Era	Period	Epoch	Years Before Present at Beginning
Cenozoic	Quaternary	Holocene (Recent)	10 thousand
		Pleistocene	2-3 million
	Tertiary	Pliocene	5-12 million
		Miocene	22-25 million
		Oligocene	36-40 million
		Eocene	58-60 million
		Paleocene	63-70 million
Mesozoic	Cretaceous		135-145 million
	Jurassic		180-210 million
	Triassic		220-255 million
Paleozoic	Permian		270-280 million
	Pennsylvanian		320 million
	Mississippian		345-360 million
	Devonian		395-415 million
	Silurian		430-465 million
	Ordovician		500-520 million
	Cambrian		570-600 million
Precambrian			4.5-4.7 billion

Adapted from several sources

Geologic Hazards

Seismicity (ground shaking, surface fault ruptures, liquefaction) and slope instability are the only geologic processes considered capable of posing a serious threat to the Port Angeles area. Consequently, only these hazards will be discussed.

Seismicity. The proposed port and onshore storage facilities are located along the western margin of a seismically active region that has several hundred earthquakes annually, most too weak to be detected without sensitive equipment. However, several damaging earthquakes have occurred in the past (Gower 1978) and the region is considered in the 1976 Uniform Building Code to be within a Seismic Risk Zone 3 (see glossary and Map Addendum). Major damage, corresponding to a Modified Mercalli Intensity VIII+ can occur here. While several surface ruptures are found in the region, none can be shown to be directly related to the several hundred instrumentally-located earthquake epicenters. The majority of the seismic activity in the Puget Sound region is believed to be associated with faults concealed by thick layers of Pleistocene and Holocene deposits (Shannon & Wilson 1978). However, the existence of these faults is uncertain.

Although several earthquakes have been noticed in the Port Angeles area, no earthquake epicenters have been identified in the immediate vicinity. Three small earthquakes, ranging from Modified Mercalli Intensity IV to VI, and one moderate earthquake (Modified Mercalli Intensity VII) have been identified within 15 miles of the proposed port; no damage was reported. The only reported earthquake damage in the port area occurred to a concrete mill in Port Angeles during the 1946 British Columbia (Strait of Georgia) earthquake, which registered 7.3 on the Richter scale (see glossary). Two other large earthquakes--Olympia in 1949 (7.0 Richter) and Seattle in 1965 (6.5 Richter)--were felt in the area, up to a Modified Mercalli VIII, but no damage was reported. See Map Addendum for locations of these earthquakes.

While all faults possess potential for future movement, only those that have shown apparent movement in the past 2-3 million years (and hence the greatest potential for future movement) are considered significant to the proposed project. Significant faults are those which could rupture the surface near the proposed port or onshore storage facilities and are divided into the following catagories.

Active faults:	those faults showing apparent movement within the past 10,000 years.
Potentially active faults:	those faults showing relative movement within the past 2-3 million years, but not the past 10,000 years (Fugro 1978a).

No surface ruptures have been identified within the immediate vicinity of the port. However, one potentially active thrust fault system is located about 2 miles south of Port Angeles (Gower 1978). (See Map Addendum.)

Although the Port Angeles area is classified as a Seismic Risk Zone 3, the absence of large magnitude earthquakes has led some seismologists to consider the area to be a Seismic Risk Zone 2 (moderate earthquake damage expected).

Potential for liquefaction occurs at the proposed port facility where drill hole data indicate the presence of loose to medium-dense fine sand 9 to 29 feet below the surface of Ediz Hook (Hart and Crowser 1976). Harbor sediments seem to be much the same as those found on Ediz Hook (loose to medium-dense sands and mud). No other potential for liquefaction has been identified within the port facilities. See Map Addendum for areas of potential liquefaction.

Slope Instability. Areas of potential slope instability (i.e., landslide) have been identified along the shoreline bluffs between Port Angeles and Dungeness Spit

(Washington Department of Ecology 1978). These bluffs consist of glacial and glaciomarine sand, gravel, silt, and (occasionally) clay in discontinous layers. They tend to be unstable at slopes greater than the angle of repose (30° to 39°) and could slump or slide (Fugro 1978a).

The nearest mapped landslide to the onshore storage facility at Green Point is approximately one-half mile to the west. According to the Washington Department of Ecology (1978a), the bluff adjacent to the onshore storage facility is potentially unstable and could be susceptible to slumping or sliding. However, a study of the bluff erosion rate, estimated to be 25 feet over the past 98 years (3 inches per year), coupled with limited geotechnical field studies indicates a relatively stable condition (Shannon & Wilson 1978). Consequently, a detailed geotechnical study of the bluff will be required before a conclusion can be reached. As the onshore storage facility is situated away from the bluff on relatively flat terrain, no slope instability has been identified.

Slope instability has not been identified on Ediz Hook. Submarine slumping of the soft bottom materials adjacent to the southern side of the hook might occur due to the relatively steep bottom slope (U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) 1976; Hart-Crowser 1976), but no submarine slumping has been identified.

See Map Addendum for known and potential areas of slope instability.

Mineral Resources

The port and onshore storage facilities contain large potential sources of aggregate (sand, gravel, boulders, etc.) as well as possible sources of peat. However, none of these resources are currently being mined.

SOILS

A general discussion of soil classifications and characteristics is provided in section 2.2, Soils.

Four major soil series, Agnew, Bellingham, Dick, and Rifle, occur at the proposed onshore storage facilities site (Clallam County Soil Survey 1951).

Agnew silty clay loam soils occupy the approximate northern third of the site. These are nearly flat terrace soils along shoreline bluffs, somewhat poorly drained. Perched water tables and seep areas commonly occur in this series.

Bellingham loam soils are in the approximate center of the site. These soils commonly occur in very poorly drained depressions with a surface covering of muck. Subsoils are clayey and mottled. Internal drainage is restricted due to impervious substratum. Perched water tables are within a few feet of the surface at some times during the year. Poor drainage, high shrink-swell potential, and high settlement rates make this soil extremely poor subgrade material (Maytin and Gilkeson 1961).

Most of the southern half of the site is occupied by Dick loamy fine sand series. These are deep, well-drained, coarse-textured soils moderately susceptible to erosion but offering good subgrade stability. A Rifle peat area occurs along the southern boundary of the site. These highly organic soils occur in undrained depressions and basin-like positions. Compact, impervious clays and stony clay subsurface material restrict drainage. These soils are worthless as subgrade material, highly compressible, subject to severe frost action, and have low shear strength (Maytin and Gilkeson 1961). Major limitations and hazard of these soils include perched water tables, high shrink-swell potential of the dense clay subsoils, and susceptibility to frost, moderate erosion, and mass movement.

Preliminary information suggests these soils are generally underlain by glacial till which in turn is underlain by glacial outwash material (USGS 1978).

Erosion of the bluff slope is active due to the extremely steep slope and erosive soil material.

AQUATIC RESOURCES

Physical Components

Surface Water Hydrology

Drainage at the onshore storage facility site is characterized by a minor hydrologic divide. The western portion drains through well-defined channels that trend north toward the Strait of Juan de Fuca. Drainage patterns in the eastern portion are not well defined because of the short distance between the divide and Siebert Creek. Runoff in this area generally flows east-northeast toward the creek (NTPC 1976).

Siebert Creek borders the eastern edge of the proposed onshore storage facility site. The U.S. Geological Survey operated a gauging station approximately 2 miles upstream of the proposed storage facility from 1952 to 1969. Average discharge for the 17-year period was 17.1 cubic feet per second (cfs), with minimum and maximum discharges of 2.0 cfs and 1,640 cfs, respectively (USGS 1975). The low flow period occurred in late summer with average flows of 2 to 5 cfs. Winter season flows typically ranged from 10 to 200 cfs.

Ground Water Hydrology

Ground water is generally abundant at the proposed site. There are discontinuous perched and regional aquifers. Perched aquifers, encountered above mean sea level (fig. 2.1-2), are recharged by precipitation and streamflow percolation. Regional water tables, located near mean sea level, are recharged by precipitation and snowmelt at higher elevations.

Ground water is discharged by flowing onto the surface (wells or springs), flowing directly into surface streams or the sea, by evaporation and transpiration, and pumping from wells (Sceva 1957). All of these discharges occur within the area, but the greatest discharge is directly into the sea below sea level (Noble 1960).

Biological Components

The only significant freshwater biological resources associated with the port or onshore storage facilities are the trout and salmon in Siebert Creek.

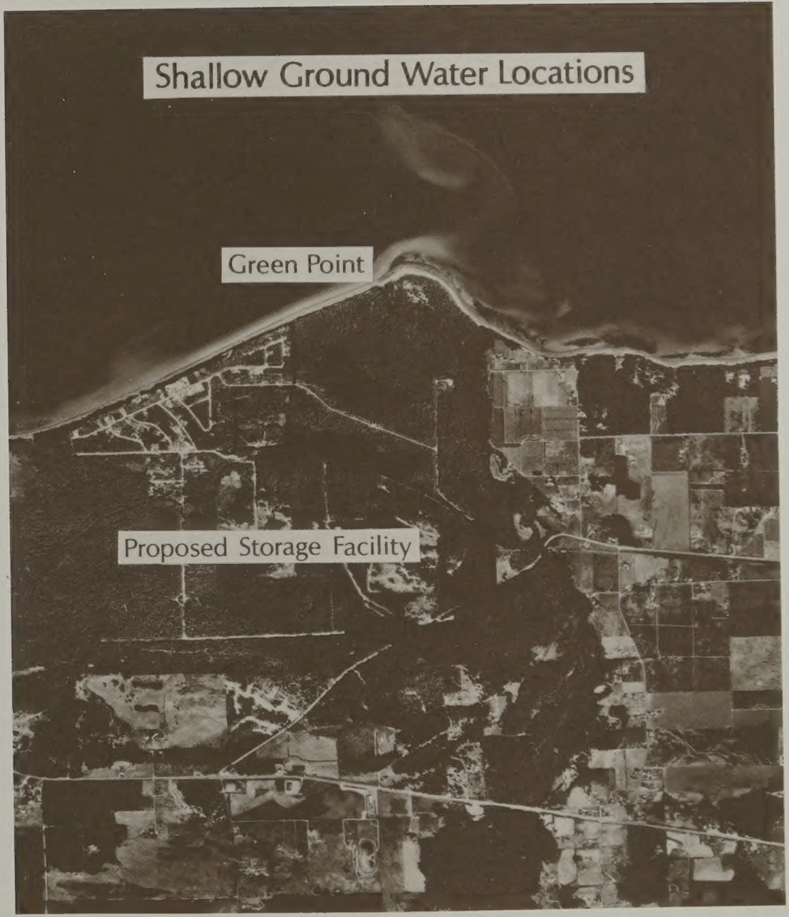


Figure 2.1-2

Source: U.S. Geological Survey 1978.

MARINE RESOURCES

Physical Components

Description

The discussion of the marine environment is limited to Grays Harbor on the outer Washington coast to Cape Flattery at the western end of the Strait of Juan de Fuca, through the Strait into northern Puget Sound and Admiralty Inlet.

The distance between Grays Harbor and Cape Flattery is about 80 miles. The continental shelf varies in width. The water depth at the shelf break averages 594 feet and is incised by numerous submarine canyons. The coastline is diverse with rocky bluffs and cliffs dominating the coast to Cape Flattery. Narrow beaches of sandy to cobble texture are irregularly interspersed.

The Strait of Juan de Fuca is about 90 miles long with water depths from 240 to 900 feet. Numerous shallower areas are concentrated near the eastern end. The width averages from 10 to 12 miles between Cape Flattery and Port Angeles Harbor.

The eastern end of the Strait of Juan de Fuca leads into Admiralty Inlet, Haro Strait, and Rosario Strait. Admiralty Inlet is the main entrance to Puget Sound. Haro and Rosario Straits are passages around the San Juan Archipelago into the Strait of Georgia.

Port Angeles is located on the southern side of the Strait of Juan de Fuca approximately 60 nautical miles inland from Cape Flattery. The harbor, a protected deep water port, is formed by Ediz Hook which is a natural barrier to prevailing wind and wave action.

The Strait of Georgia is about 18.5 nautical miles wide between Point Roberts and the north point of Galiano Island and extends southeasterly to Boundary Passage. Its width is about 16 nautical miles between Lummi Bay and Saturna Island. The eastern strait is bordered by Washington state inner coastline; it is characterized by numerous banks and bays. The western border is bounded by the inner islands east of Vancouver Island and is characterized by bays, sea cliffs, and rocky shoreline. Water depths along the axis of the strait, within the area of interest, vary from 400 to 750 feet.

Oceanographic Conditions

The principal current in the northeast Pacific Ocean is the Subarctic Current, or West Wind Drift Current, which diverges off the west coast of North America. This divergence causes the formation of the north-setting Alaskan Current and the south-setting California Current. In the summer the divergence occurs at about 45°N latitude, as shown in figure 2.1-3. During summer, northwest winds blow parallel to the coast, causing the surface water to move away from the coast. The result is an upwelling of cold, highly saline, nutrient-rich water. This divergence of surface water and the northwest winds may enhance the southerly flow of the California Current.

In winter the Subartic Current diverges at about 40°N latitude. At this time the north-setting Davidson Countercurrent develops inshore of the Alaskan and

California Currents as shown in figure 2.1-4. It develops off the Washington coast in September and is well established by January. Towards spring it diminishes and by May disappears. A deep countercurrent flows north all year round.

Wave directions off the Washington coast exhibit definite seasonal patterns in response to wind direction. The predominant wave approach is from the northwest during the summer months and from the southwest in the winter months. Data on wave heights and their percent of occurrence are given in table 2.1-11.

TABLE 2.1-11 WAVE DATA FOR THE WASHINGTON COAST
(Frequency of Occurrence, in Percent)

Deep Water Wave Height (Highest 1/3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Northern Washington (35 nautical miles west of Kalalock)													
9'+	32.9	30.2	28.5	5.0	4.4	3.8	5.4	2.0	8.3	24.1	33.1	44.4	18.1
15'+	7.4	4.8	7.4	0.3	0.3	0.0	0.3	0.0	0.9	4.5	5.1	10.7	3.4
19'+	3.6	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.2	4.1	0.9
Entrance to Strait of Juan De Fuca													
9'+	7.6	11.7	8.1	1.4	2.7	2.3	4.5	0.3	4.8	11.7	20.9	15.9	7.4
15'+	1.6	1.5	1.7	0.0	0.0	0.0	0.3	0.0	0.0	2.2	3.9	2.3	1.0
19'+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	0.2

Source: Oceanographic Institute of Washington 1977

The wave data indicate that one-third of the waves approaching the northern Washington coast will be 15 feet or greater 10 percent of the time during December; whereas, at the entrance to the Strait such large waves occur only 2.3 percent of the time. The majority of open ocean waves are dispersed as they enter the Strait. Maximum wave height within the inner Strait is about 15 feet.

Strait of Juan de Fuca

The Strait of Juan de Fuca is generally quite deep, but there are shallow areas, or sills, which tend to inhibit the flow of saltwater into the inland water system. The sills are formed by glacial deposition and affect water characteristics, the time required to replenish water in the inland system, and biological processes.

Generally, the movement of water within the system has three parts: a low salinity surface layer flowing seaward, a salty dense oceanic layer flowing landward near the bottom, and a mixture of the two waters which forms at the sills and contributes to

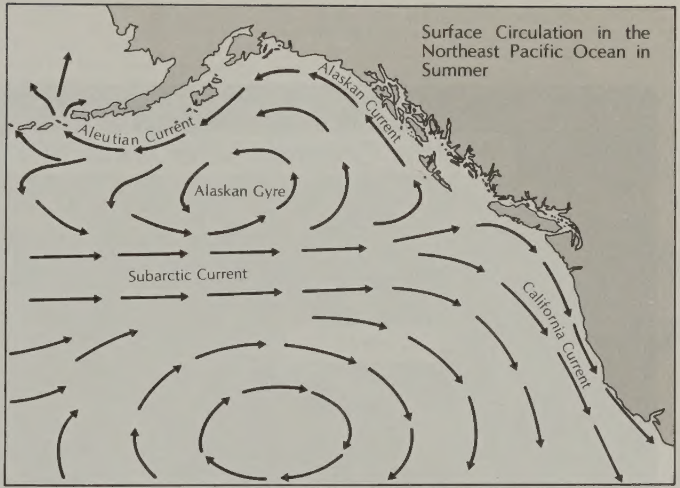

Surface Circulation in the Northeast Pacific Ocean in Summer

Figure 2.1-3

Source: Fisheries and Environment Canada 1978

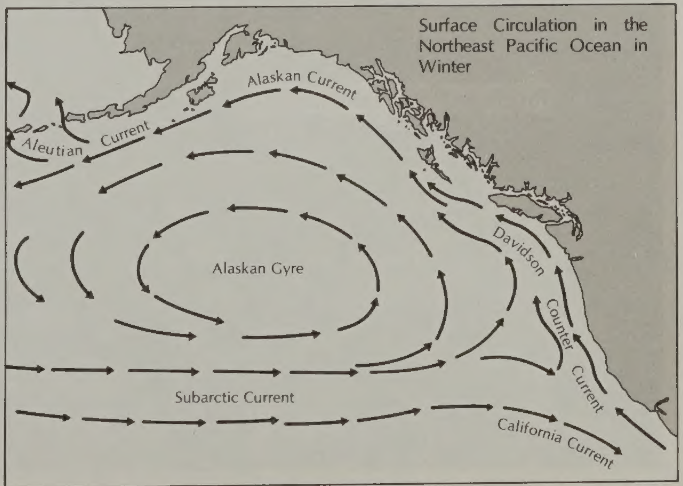

Surface Circulation in the Northeast Pacific Ocean in Winter

Figure 2.1-4

Source: Fisheries and Environment Canada 1978 both the surface and deep water layers. The low salinity surface layer is a result of freshwater input from rivers, predominately the Fraser River in Canada.

Surface flow is influenced by tidal currents and freshwater input; net flow is seaward. Surface drift cards released in the spring, summer, and winter showed an overall seaward movement (see figure 2.1-5). The data also suggest the strong influence of freshwater input and the presence of the southerly flowing California current along the coast during the spring (Cannon 1978).

Results of surface drifters released in the vicinity of Port Angeles show a tendency for shoreward dispersion, associated with complex tidal currents and westerly winds. Of the deployed drift sheets, 34 percent were sighted or recovered ashore. Of those cards recovered, 97 percent were found landward and 3 percent found seaward of the release sites. These results are shown in table 2.1-12.

TABLE 2.1-12 RECOVERY LOCATIONS AND PERCENTAGES OF TOTAL DRIFT SHEETS RECOVERED ASHORE

Location	Percentage Ashore (Expressed as % of total recoveries)
Port Angeles Harbor	19
Between Port Angeles Harbor and Morse Creek	17
Outer Dungeness Spit	43
Outer Ediz Hook and west to Angeles Point	21

Source: Ebbesmeyer et al. 1978

Drift cards released in Port Angeles and vicinity also showed a tendency to ground ashore.

Recent research near Pillar Point, northwest of Port Angeles, indicates the existence of an apparent cross channel current in addition to tidal currents which, at the surface, move toward the southern side of the Strait (Ebbesmeyer et al. 1977).

Port Angeles

The Port Angeles harbor is an area of deep water close to shore; maximum depth is 192 feet. Depth contours and south to north profiles of the harbor are presented in figure 2.1-6.

Within Port Angeles harbor, less-dense, lower salinity water moves seaward on or near the surface while the deeper water migrates landward. The net seaward movement in the harbor is about 2 miles per day. Stratification of the water is sufficient to prevent downward movement of most freshwater wastes (Federal Water Pollution Control Administration 1967).

Currents in the harbor are dominated by tidal action. One tidal current model for the harbor suggests that the water between Ediz Hook and Dungeness Spit flows in an eddy with nearshore currents flowing opposite to tidal currents in the Strait. The western boundary of this eddy is usually located just inside the harbor entrance. The eddy flows counter-clockwise with a net eastward movement caused by a net seaward flow in the Strait. During incoming or flood tide the currents in the harbor are stronger on the south side, causing a net counter-clockwise flow in the inner harbor.

The water level may either rise or fall on both flood and ebb currents in the Strait. This apparent paradox results from the interaction and reflection of tidal currents in other portions of inland water basins (Federal Water Pollution Control Administration 1967).

A more recent circulation model suggests that the dominant circulation pattern is a clockwise eddy with the center immediately west of the harbor entrance. The eddy splits east of the entrance and a longshore current moves easterly toward Dungeness Spit (see figure 2.1-7). This dominant eddy motion may weaken with approaching flood and completely disappear when the flood has been established and an easterly to southeasterly current predominates across the mouth of the harbor, as figure 2.1-8 indicates. This circulation pattern may develop into a weak counter-clockwise rotation on the ensuing ebb tide (see figure 2.1-9). This counter-clockwise pattern, in turn, may give rise to currents flowing almost due south near the tip of the Ediz Hook, as shown in figure 2.1-10 (Tollefson et al. 1971).

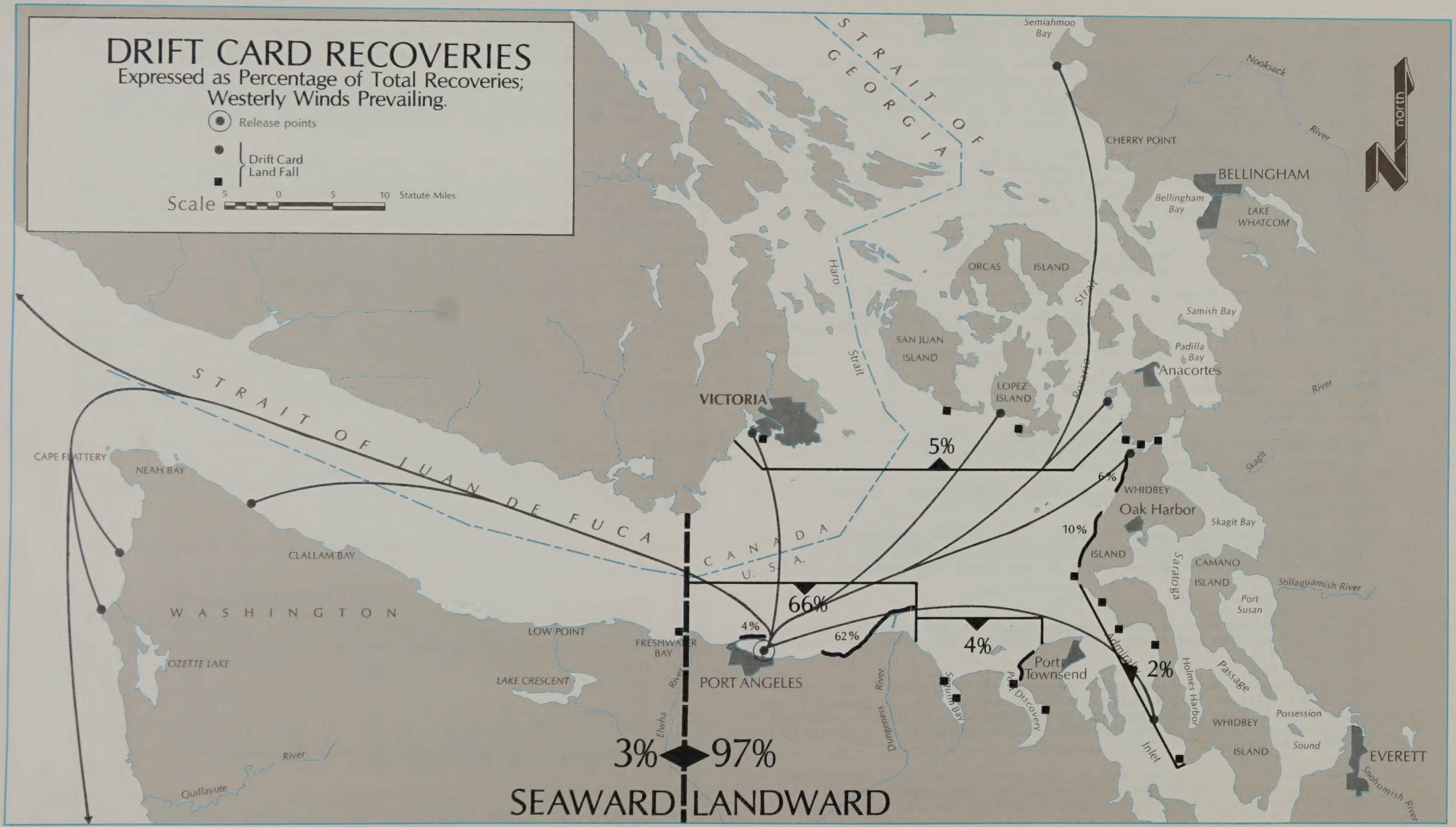
Tidal currents within Port Angeles harbor are weak and variable. The mean tidal range is 4.2 feet and the diurnal range is 10.9 feet (U.S. Department of Commerce 1979). Maximum flood tidal currents in the harbor varied between 0.5 to 0.7 knots. On the ebb the velocities were less than 0.5 knots. Maximum velocities measured 1 mile north of Ediz Hook ranged from 0.9 knots to 1.4 knots for flood tidal currents and from 1.0 to 1.7 knots for ebb tide velocities (Oceanographic Institute of Washington 1974).

Sheltered by Ediz Hook, waves within Port Angeles Harbor are usually small, because the distance over which the wind can generate waves is limited. The Hook protects the harbor from ocean swells and from local wind-generated waves from all directions except the northwest (see table 2.1-13). Local wind-generated waves would not exceed 8 feet.

TABLE 2.1-13 WAVE FORECASTS FOR LOCALLY GENERATED SEA WAVES AT EDIZ HOOK

Direction of Approach	Annual Percentage of Occurrence (1-3 ft.)	Annual Percentage of Occurrence (3-5 ft.)
West	28.0	2.0
Northwest	15.5	2.0
North	3.5	
Northeast	5.0	0.5
East	6.3	0.5

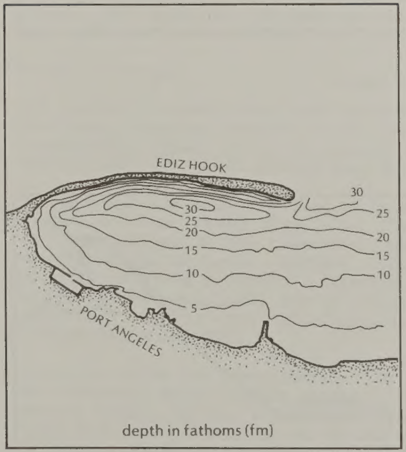
Source: U.S. Army Corps of Engineers 1971



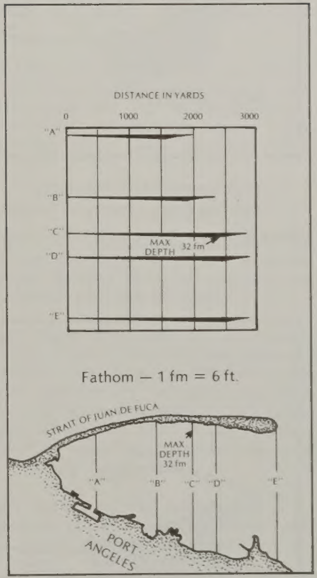
DRIFT CARD RECOVERIES
Expressed as Percentage of Total Recoveries;
Westerly Winds Prevailing.

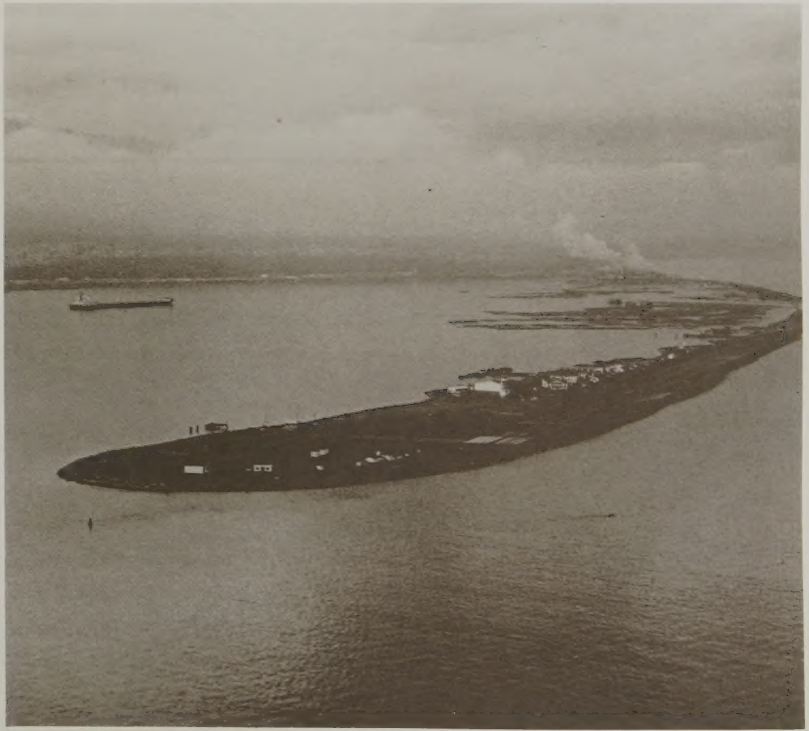
Source; Ebbesmeyer, et al 1978.

Bathymetry of Port Angeles Harbor



Profiles of Port Angeles Harbor





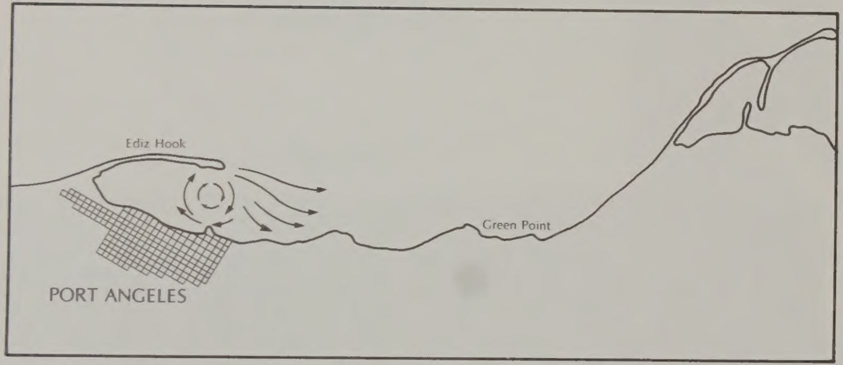
BATHYMETRY AND PROFILES OF PORT ANGELES HARBOR

Figure 2.1-6

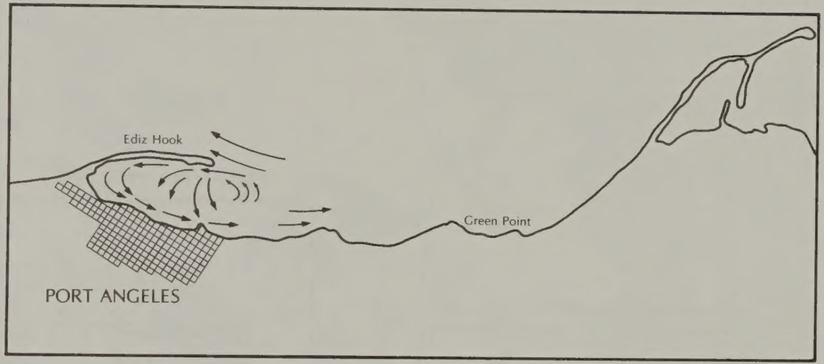
Source: Federal Water Pollution Control Administration 1968

Source: BLM

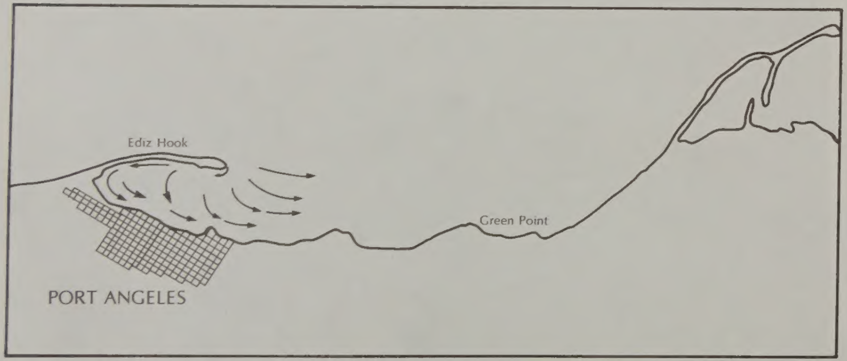
GENERALIZED PATTERNS OF WATER MASS MOVEMENTS



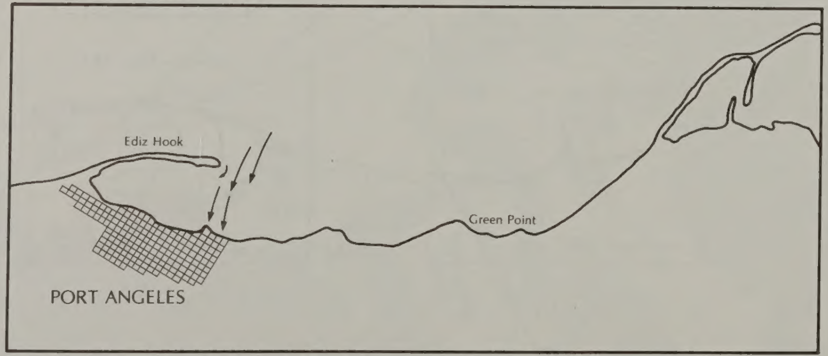
Dominant Clockwise Eddy Pattern—
Strongest During First Half of Ebb
Figure 2.1-7



Weak Counterclockwise Eddy—
Resulting From Easterly to Southeasterly Current Pattern
Figure 2.1-9



Easterly to Southeasterly Current Pattern—
Occuring Intermittently During Onset of Flood
Figure 2.1-8



Source: Tollefson 1971

Southerly Current Pattern—
Resulting From Weak Counterclockwise Eddy
Figure 2.1-10

Dungness Bay and Spit

Dungeness Spit and Dungeness Bay are also located on the southern shoreline of the Strait of Juan de Fuca, approximately 9 nautical miles east of Port Angeles Harbor. The geomorphology of the spit indicates the complexity of coastal processes in the area. Outer Dungeness Spit is a long, narrow sand bar extending northeasterly into the Strait. The inner spit bisects the outer spit and extends southerly 1.1 nautical miles toward the mainland. Dungeness Bay encompasses all waters within the two spits and outer waters to the mouth of Sequim Bay, located 6.5 nautical miles southeast of the bay.

Inner Dungeness Bay is shallow and well protected from waves; the controlling entrance depth is 1.5 feet and the entrance width is 0.2 nautical miles. The greatest depth within the bay is 21 feet. Wave heights between 0.5 to 2 feet are usually from the west or northwest (Washington State Department of Ecology 1978). Inner bay sediments are mud, sand, and sandy-mud.

In the outer bay wave heights can be from 2 to 4 feet out of the west or northwest (Washington State Deparment of Ecology 1978). The mean tidal range is 4.4 feet and the diurnal range is 7.6 feet; mean tidal velocities are 0.5 knots on flood and 1.2 knots on ebb, at 2.8 nautical miles north-northwest of New Dungeness Light House. (U.S. Department of Commerce 1979). The Dungeness River flows into the outer bay; sandy mud flats are found near its mouth.

Strait of Georgia

The seasonal surface circulation pattern in the Strait of Georgia is dominated by freshwater discharge from the Fraser River, causing the development of an estuarine circulation. There is a net seaward flow of surface waters with an approximate velocity of 1 to 2 knots through Haro Strait and the Strait of Juan de Fuca.

In the Strait of Georgia surface circulation is more complicated than in the Strait of Juan de Fuca. Fraser River water usually enters the Strait from the main channel as a well defined surface plume that frequently traverses the Strait to Porlier Pass before turning southward. Surface currents off Point Roberts are variable and show no persistant flow direction. Currents are strongly influenced seasonally by local meteorological conditions, and by fluctuations in the discharge from Fraser River. Subsurface currents are complicated, but generally flow northward (Fisheries and Environment Canada 1978).

Prevailing winds are predominately from the southeast during winter months and from the northwest during summer months. Based upon meteorological data gathered off Saturna Island, Canada, significant wave heights off Point Roberts are predicted to range from 3 to 3.5 feet out of the southeast in the winter, and 0.5 feet or less out of the northwest in the summer (U.S. Army Corps of Engineers 1977; Fisheries and Environment Canada 1978).

Strong tidal currents occur in restricted passages in the Strait of Georgia, San Juan Archipaelogo, Boundary Passage, and northern Haro Strait. Tidal currents in most passages are reversing and the predominant flow direction is along the main axis of the channels. Near Sucia Island, the mean tidal range is 5.2 feet and the diurnal range is 8.6 feet. The average tidal currents near the island are 0.8 knots on the flood at 25° true and 1.4 knots on the ebb at 205° true (U.S. Department of Commerce 1979).

The central Strait of Georgia, off Point Roberts, is a region where freshwater from the Fraser River creates a low salinity surface layer in summer. Renewal of deep water occurs throughout the year and those intrusions appear to originate in the island regions (Fisheries and Environment Canada 1978).

Marine Water Quality

Washington State marine water quality standards contain four classifications, each based on characteristic uses to be protected. Marine water is classified by water quality criteria, such as fecal coliform count, dissolved oxygen, total dissolved gas, temperature, pH, turbidity, toxic, radioactive or deleterious materials, and aesthetic values. These criteria are listed in table 2.1-14.

Marine waters on the outer coast, in the Strait of Juan de Fuca, within and around the San Juan Archipelago, and in the Strait of Georgia are classified extraordinary or Class AA (Washington State Department of Ecology 1977). The location of the marine water classifications is shown in the Map Addendum.

Port Angeles harbor water is classified excellent or Class A. A rating lower than that of the adjacent Strait results from pulp mill activities, log storage and rafting, and treated sewage effluent (Washington State Department of Ecology 1977). No water classification is available for inner Dungeness Bay.

Marine Sediments

Marine sediments range from mud and clay to rock. Sediments along the outer coast are characteristically sand and rock. The axis of the Strait of Juan de Fuca is predominately mixed with areas of sand, rock, and gravel along the southern shore. Sediments in the bays and inlets range from clay and mud to rock (see Map Addendum).

Hydrocarbon concentrations were measured in mussel and sediment samples collected in the Strait of Juan de Fuca, near the San Juan Islands, and in northern Puget Sound. The samples were analyzed for saturated and unsaturated hydrocarbons, aromatic hydrocarbons, total organic carbon, sand to mud ratio, lipids (fats), and total solids (see table 2.1-15.)

The results indicate that the concentrations of n-alkanes with 12 to 20 carbon atoms in mussel samples was generally higher than corresponding concentrations in sediments. The average value for mussels was 900 ng/g dry weight, and for sediments 50 ng/g dry weight. The results indicate that all sites were relatively free from petroleum hydrocarbon contamination. Analysis of hydrocarbon composition at Ediz Hook, Baadah Point, and March Point indicated the presence of some petroleum hydrocarbons from local industries, municipal sewage inputs, or commercial or sports boating activities (Brown et al. 1979).

Low molecular weight hydrocarbons were measured in marine waters of the eastern Strait of Juan de Fuca, Haro and Rosario Straits, and the southern Strait of Georgia. The study delineated current levels of dissolved methane, ethane, ethene, propane, propene, and iso- and normal-butanes which are useful indicators of petrogenic contamination. The results of the study suggest some petrogenic input from Puget Sound; however it is relatively small. Overall, it appears that little petroleum hydrocarbon pollution exists in marine waters of northern Puget Sound (Baker et al. 1978).

TABLE 2.1-14 SUMMARY OF WASHINGTON STATE MARINE WATER QUALITY STANDARDS

Parameter	CLASS AA (Extraordinary)	CLASS A (Excellent)	CLASS B (Good)	CLASS C (Fair)
Fecal Coliform Organisms (organism/100 ml)	Shall not exceed a median value of 14 organisms/100 ml, with not more than 10% of samples exceeding 43 organism/100 m.	Shall not exceed a median value of 14 organisms/100 ml, with not more than 10% of samples exceeding 43 organisms/100 ml.	Shall not exceed a median value of 100 organisms/100 ml, with not more than 10% of samples exceeding 200 organisms/100 ml.	Shall not exceed a median value of 200 organisms/100 ml, with not more than 10% of samples exceeding 400 organisms/100 ml.
Dissolved Oxygen (mg/l)	Shall exceed 7.0 mg/l, except when the natural phenomenon of upwelling occurs, natural dissolved levels can be degraded by up to 0.2 mg/l by man-caused activities.	Shall exceed 6.0 mg/l, except when the natural phenomenon of upwelling occurs natural dissolved levels can be degraded by up to 0.2 mg/l by man-caused activities.	Shall exceed 5.0 mg/l or 10% saturation, whichever is greater, except when the phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.	Shall exceed 4.0 mg/l or 50% saturation, whichever is greater, except when the natural phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.
Total Dissolved Gases	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% saturation at any point of sample collection.
Temperature	Shall not exceed 13.0° Celsius due to human activities. When natural conditions exceed 13.0° Celsius, no temperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.	Shall not exceed 16.0° Celsius due to human activities. When natural conditions exceed 16.0° Celsius, no termperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.	Shall not exceed 19.0° Celsius due to human activities. When natural conditions exceed 19.C° Celsius, no temperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.	Shall not exceed 22.0° Celsius due to human activities. When natural conditions exceed 22.0° Celsius, no temperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.
pH	Shall be within the range of 7.0 to 8.5 with a man-caused variation within a range of less than 0.2 units.	Shall be within the range 7.0 to 8.5 with a man-caused variation within a range of less than 0.5 units.	Shall be within the range of 7.0 to 8.5 with a man-caused variation within a range of less than 0.5 units.	Shall be within the range of 6.5 to 9.0 with a man-caused variation within a range of less than 0.5 units.
Turbidity (Nephelometric Turbidity Units)	Shall not exceed 5 NTU over background turbidity when background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when background turbidity is more than 50 NTU.	Shall not exceed 5 NTU over background turbidity. When background, turbidity is 50 NTU or less, or have more than 10% increase when the background turbidity is more than 50 NTU.	Shall not exceed 10 NTU over background turbidity when background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background turbidity is more that 50 NTU.	Shall not exceed to 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, Radioactive or Deleterious Material Concentrations	Shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any use.	Shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.	Shall be below those which adversely affect public health during characteristic uses, or which may cause acute or toxic conditions to the aquatic biota, or which may adversely affect characteristic water use.	Shall be below those which adversely affect public health during characteristic uses, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect characteristic water use.
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.	Shall not be impaired by the presence of materials or their effects, excluding those of matural origin, which offend the senses of sight, smell, touch, or taste.	Shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.	Shall not be interfered with by the presence of obnoxious wastes, slimes, aquatic growth, or materials which will taint the flesh of edible species.

Adapted from Washington State Water Quality Standards 1977.

TABLE 2.1-15 HYDROCARBON BASELINE DATA FOR SEDIMENTS AND MUSSEL AT SELECTED SITES IN THE STRAIT OF JUAN DE FUCA AND NORTHERN PUGET SOUND

	Sediment						Mussel					
Site	Average Total Saturated Hydrocarbons µg/g 2/ (Dry Weight)	Average Total Un-Saturated Hydrocarbons µg/g (Dry Weight)	Average Sum of Selected Alkanes (nC_{12}-C_{20}) ng/g (Dry Weight)	Average Sum of Selected Aromatic carbons 1/ ng/g (Dry Weight)	Average Total Organic Carbon (%)	Average Sand-to-Mud Ratio	Average Total Saturated Hydrocarbons µg/g 2/ (Dry Weight)	Average Total Un-Saturated Hydrocarbons µg/g (Dry Weight)	Average Sum of Selected Alkanes (nC_{12}-C_{20}) ng/g (Dry Weight)	Average Sum of Selected Aromatic Hydrocarbons 1/ (Dry Weight)	Average Total Lipid (fats) (% dry weight)	Average Total Solids (%)
Baadah Point	4.1	3.0	55	19	0.13	160	210	220	710	200.0	13.2	16.0
Kydaka Point	3.1	2.0	100	29	0.13	120	34	220	660	9.3	10.0	10.3
Pillar Point	3.0	5.9	36	2	0.20	57	27	220	300	12.0	11.0	18.5
Tongue Point	2.3	4.3	23	2	0.15	93	37	165	260	3.3	10.4	15.4
Ediz Hook	18.0	5.0	150	8	0.11	130	200	500	5400	2500.0	13.3	12.5
Dungeness Spit	1.2	1.5	14	1	0.06	170	-	-	-	-	-	-
Dungeness/ Three Crabs	3.7	7.0	86	13	0.35	8	16	280	630	90.0	8.9	12.4
Cape George	1.4	1.6	22	2	0.1	39	12	160	630	90.0	11.0	14.7
Port Casey	1.1	0.9	25	1	0.1	210	-	-	-	-	-	-
Keystone	-	-	-	-	-	-	86	260	870	140.0	11.0	12.4
Naval Air Station, Whidbey Island	1.5	0.8	8	1	0.08	180	130	380	820	13.0	10.7	14.0
March Point	8.5	7.9	100	39	0.19	150	110	310	670	220.0	13.5	16.7
Alexander Beach	2.7	2.6	21	2	0.15	99	120	320	1300	69.0	12.3	16.0
Lummi	-	-	-	-	-	-	59	260	790	170.0	11.2	14.3
Cherry Point	3.3	2.2	33	9	0.13	150	-	-	(760)3/	(300.0)3/	(7.5)3/	(8.8)3/

Source: Brown et al. 1978.

1/ The sum of selected aromatic hydrocarbons are: naphthalene; 2 - methylnaphthalene; 1 - methylnaphthalene; 2,6 - dimethylnaphthalene; 2,3,5 - trimethylnaphthalene; phenanthrene; anthracene; 1 - methylphenanthrene; benzo (ϵ) pyrene; and benzo (α) pyrene.

2/ µg/g = 10^{-6} grams per gram of sediment; ng/g = 10^{-9} grams per gram of sediment.

3/ Not a quarterly average, but a single analytical determination for Spring.

Habitats

Washington State Department of Ecology (1975) has defined nine general habitat types by prominent physical and biological characteristics: rock, sand, mud, mixed-coarse, mixed-fine, kelp bed, eelgrass, salt marsh, and open water. A summary of the physical and biological characteristics of each habitat is given in table 2.1-16 and is shown in the Map Addendum. Preferred habitats for various bottom organisms, fish families, birds and mammals are given in tables 2.1-17 and 2.1-18 (Washington State Department of Ecology 1977).

Distribution of Marine Resources

The outer Washington coast, Strait of Juan de Fuca, San Juan Archipelago, Strait of Georgia, and Puget Sound are rich in marine resources. These areas support abundant clams, shrimp, crab, fin fish, marine mammals, and diverse and abundant bird populations.

Commercial and sport fisheries are found on the outer coast and in the western Strait, but not to the extent they are found in the eastern Strait or Puget Sound (Washington Department of Natural Resources 1977; Squire, Jr. and Smith 1978). The general distribution of marine resources of sport and commercial value is shown in the Map Addendum. The distributions portrayed for bottom fish and salmon represent the areas harvested. Birds are abundant due to nesting, resting, feeding and wintering habitat for waterfowl such as plunge divers, divers, diving ducks, dabbling ducks, geese, and shore birds. See the Map Addendum for distribution of these groups.

Thirteen marine areas are believed to be particularly important relative to this project because they are biologically very important and are in areas that are most likely to be impacted. These areas are: outer coast from Cape Flattery to and including Grays Harbor, Neah Bay to Port Angeles, Port Angeles, Green Point, Dungeness Spit and Bay, Sequim Bay, Discovery Bay, Protection Island and Dallas Bank, Admiralty Inlet, Whidbey Island--the west side from Admiralty Inlet north, Smith and Minor Islands, Skagit Bay, and Saratoga Passage. Each area is discussed in detail. The first five are discussed below while the last eight are discussed under the pipeline section of Marine Resources.

Some areas are referred to as critical or important habitat. The significance of an area is defined by the Washington Department of Ecology (November 1977) as:

1. An area which supports a population species that not only consistently reproduces itself but because of favorable environmental conditions provides the major source of recruitment for adjacent areas whose populations do not consistently reproduce themselves.
2. An area which consists of a habitat type or types that provide shelter, food, or other environmental necessities during a critical part of a species' life history.

TABLE 2.1-16 CLASSIFICATION OF TIDAL HABITAT TYPES

Type	Substrata	Physical Characteristics			Biological Characteristics
		Wave and Current Action	Tidal Range	Slope	
Rock	Solid rock or very large, stable boulders	High to low	All	Any (if low, waves or currents usually high)	Productive. Diverse fauna at mid to lower intertidal; algae abundant. Important subtidal fish.
Sand	Approximately 4 to 0.25 mm( )	High to moderate	All	Shallow	Relatively unproductive, low diversity. Few algae. Some hardshell clams, crab nursery area (intertidal), adult crabs (subtidally).
Mud	Fine sand, silt, and clay (0.25mm)	Low	All	Shallow	Productive and diverse. Important oyster beds. Some clam production; some crab use. Often with eelgrass. Important subtidal fish; shorebird feeding; harbor seal haul out.
Mixed-coarse	Mostly cobble (256-64 mm), gravel (64-4mm), and sand with low mud or silt content. May have some scattered boulders (256 mm)	High to moderate	Intertidal to shallow subtidal	Medium	Relatively unproductive. May have hardshell clams, especially subtidally.
Mixed-fine	Mixed cobble, gravel sand, and shell fragments with high mud and silt content. May have scattered boulders.	Moderate to low.	All (usually below MSL)	Medium to shallow	Rich and diverse fauna. Important clam production; subtidal fish and crabs. Some eelgrass subtidally; algae attached to shell fragments and larger substrates.
Open water	Salt water medium which fluctuates in salinity, temperature	Variable	-	-	Wide variety of fish. Offshore feeding area for birds and marine mammals. Abundant phytoplankton and zooplankton.
Kelp bed	Mostly, brown kelp (*Nereocystis leutkeana*) attached to rock of cobble-size or greater.	Usually moderate but is variable	Depth from near MLLW to 50 feet below	Any	Good fish and invertebrate habitat. Several species of large brown algae and low-light tolerant red algae under *Nereocystis* canopy.
Eelgrass	Formed by dense beds of eelgrass (*Zostera*) on sand, muddy sand, or muds.	Moderate to low	Approximately from +3 feet to -12 feet relative to MSL	Mostly shallow. may be moderate along channels	Major food source for brant and many invertebrates. Crab and fish nursery. Herring spawning. Many algae species epiphtic on eelgrass. Effective trap for detritus.
Saltmarsh	Several species of gramminoid plants, forbs and herbs other than grasses on mud or mixed-fine with high organic content.	Low	Usually above	Shallow	Important breeding and feeding for waterfowl and nongame birds.

Source: Washington State Department of Ecology 1975.

MSL = mean sea level; MLLW = mean lower low water; MHW = mean high water. Grain sizes of 0.25 to 0.06 mm are often considered fine sand

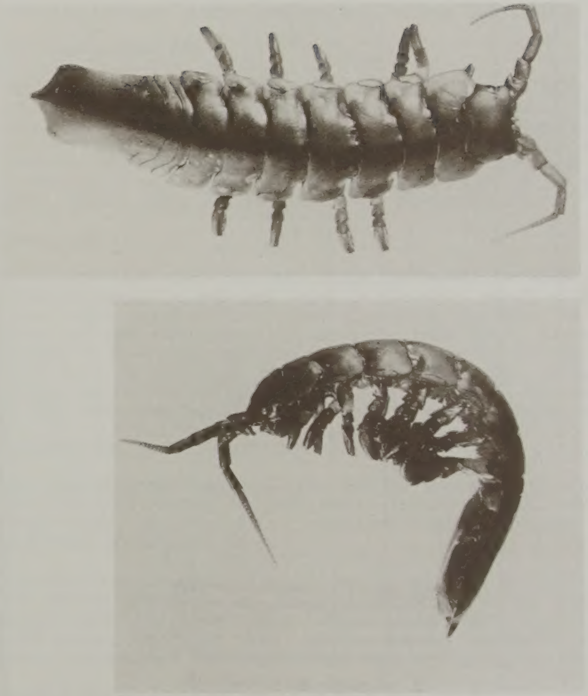
TABLE 2.1-17 PREFERRED HABITAT TYPES FOR VARIOUS MARINE ORGANISMS

Organisms	Utili-zation	Habitat								
		Open* Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Beds	Salt Marsh
Benthic Phyla										
Echinoderms (starfish, urchins,etc.)	C,S	X	X	X	X	X	X	X	X	
Crustaceans (crabs,shrimp, etc.)	C,S	X	X	X	X	X	X	X	X	X
Annelids (worms)	S	X	X	X	X	X				
Molluscs (oysters, clams,etc,)	C,S	X	X	X	X	X	X	X		
Fish Families										
Sable fish	C,S	X		X				X	X	
Greenlings	C,S	X	X		X	X	X	X	X	
Flounder	C,S	X		X	X	X	X	X		
Toadfish		X		X	X	X	X	X		
Codfish	C,S	X	X	X		X	X	X		
Wolffish	S	X	X			X				
Scorpion fish (rock fish)	C,S	X				X	X	X	X	
Sturgeon	S	A		X	X					
Sculpins	S	X	X	X	X	X	X		X	
Surfperch	C,S	X	X	X	X	X	X	X	X	
Gunnels		X	X	X	X	X	X	X	X	
Herring	C,S	X	X	X	X	X	X	X	X	
Anchovie	C,S	X	X	X	X	X		X		
Salmonids	C,S	A		X		X	X			
Smelt	C,S	A,X		X		X	X			
Drum	S	X							X	
Sandlance		X	X	X	X	X	X			
Sharks	C,S	X	X	X	X	X	X		X	
Skates	C,S	X	X	X						
Chimaeras		X	X	X		X	X			
Plankters										
Phytoplankton		X								
Permanent zooplankton		X								
Temporary zooplankton (fish and benthic larvae)		X								

Source: Washington State Department of Ecology 1977.

*Where open water is checked for organisms, the associated bottom habitat types for those organisms are also checked. The habitat types checked are for any life stage (larval or adult). This chart does not imply that organisms do not range into other habitats.

Legend: X = organisms found in this habitat during some or all life stages;
A = anadromous fishes; C = commercial fishing; S = sports fishing.



Crustacean

Mollusk

U.S. Fish and Wildlife Service

TABLE 2.1-18 PREFERRED HABITAT TYPES FOR VARIOUS MARINE MAMMALS AND BIRDS

Organism	Status[1]	Utilization[2]	Open-water	Rock	Sand	Mud	Mixed coarse	Mixed fine	Eel-grass	Salt marsh	Kelp beds
Birds											
Black oystercatchers		R		X			X				
Surfbirds		R		X			X				
Ruddy turnstones		R		X			X	X			
Black turnstones		R		X			X	X			
Wandering tattlers		R		X							
Spotted sandpipers		R		X		X		X			
Rock sandpipers		R		X	X		X	X			
Western sandpipers		R		X	X	X		X			
Great Blue Herons		R		X	X	X	X	X		X	
Plovers		R			X	X		X			
Yellowlegs		R			X	X		X		X	
Dunlins		R				X					
Dowitchers		R				X		X		X	
Whimbrels		R				X				X	
Killdeer		R				X	X				
Belted kingfisher		R				X	X	X			X
Cormorants		R	X	X			X				X
Common murres		R	X	X							
Marbled murrelets		R	X	X							
Rhinoceros auklets		R	X	X							
Pigeon guillemots		R	X	X							X
Gulls		R	X	X	X	X	X	X	X		X
Tufted puffins		R	X	X							
Terns		R	X		X						
Parasitic jaeger		R	X								X
Wilson's snipe		R								X	
Crows		R		X	X	X	X	X		X	
Ravens		R		X	X	X	X	X		X	
Bald eagles[3]	T[1]	R		X	X	X		X			
Ospreys		R				X					
Snowy owls		R								X	
Short-eared owls		R								X	
										X	
Marsh hawks		R									
Gyrafalcons		R								X	
Peregrine falcons	E	R								X	
Merlins		R								X	
Violet-green swallows		R								X	
Savannah sparrows		R								X	
Harlequin ducks		S R	X	X							
Black brants		R	X		X		X	X	X		
Pintails		S R	X			X		X		X	
Green-winged teal		S R	X			X		X		X	
Mallards		S R	X					X		X	
Scoters		S R	X						X		X
Scaup		S R	X						X		
Loons		R	X						X		
Grebes		S R	X						X		
Coots		S R	X							X	
American widgeon		R	X						X	X	
Canvasbacks		S R								X	
Buffleheads		S R	X			X				X	
Canada geese		S R	X			X				X	
Mammals											
Seals		R	X	X	X	X	X	X	X	X	X
Sea lions		R		X			X				X
Whales	E	R	X								
Porpoises		R	X								
Otters		C[2]R		X	X		X	X	X	X	X
Raccoons[3]		SCR		X	X		X	X		X	
Stripped[3] skunks[3]		C R		X			X			X	
Opossums[3]				X						X	
Muskrats[3]		C R		X						X	
Minks[3]		C R								X	
Ermines[3]		C R								X	

Sources: Washington State Department of Ecology 1977; Federal Register 40(135), 3642-36431

Legend: Primary habitat available for bird usage. E = endangered species; T = threatened species; R = recreational value (bird watching); C = commercial value; S = sports value

[1] Threatened in Washington state and four other states. [2] River otters only. [3] Frequent visitor to marine habitats.

Outer Coast - Cape Flattery to Grays Harbor

For a detailed discussion of this area refer to "A Summary of Knowledge of the Oregon and Washington Coastal Zone and Offshore Areas" (Oceanographic Institute of Washington 1977) and "Washington Coastal Areas of Major Biological Significance," (Washington Department of Ecology 1977). The following remarks will briefly highlight some of the more important biological resources.

Marine life in this region supports a variety of commercial fisheries. Cape Flattery to Destruction Island is an important trawl ground for ocean perch, rockfish, lingcod, sable fish, Pacific cod, Dover and English sole, and starry flounder. Petrale sole are trawled from Destruction Island south past Grays Harbor to the Columbia River, while ocean pink shrimp are trawled from Cape Johnson to Willapa Bay. Particularly important shrimping areas occur within and offshore Grays Harbor. Salmon trolling occurs throughout this area and other important commercial species include Pacific herring, anchovy, and tuna.

The coast between Cape Flattery and Grays Harbor includes three National Wildlife Refuges (NWR): Flattery Rocks NWR, Quillayute NWR, and Copalis NWR. Hundreds of offshore rocks, islets, and islands provide habitat for many species of birds and marine mammals. South of Point Greenville in the Copalis NWR the character of the coast becomes sandy and important sand-marsh-mud habitats are found in river mouths and Grays Harbor.

The Washington Department of Ecology (1977b) lists many critical habitats within this section of coast. Tatoosh Island off Cape Flattery, just north of Flattery Rocks NWR boundary, is a critical habitat for Brandt's cormorant, pelagic cormorant, glaucous winged gull, Thayer's gull, common murre, pigeon guillemot, tufted puffin and the black oyster catcher. Within Flattery Rocks NWR there are 9 critical habitats for Steller sea lion, harbor seal, sea otter, and river otter. Critical habitat exists for the pelagic cormorant, glaucous winged gull, tufted puffin, black oyster catcher, common murre, and northern bald eagle, while important habitat is listed for the wandering tattler and surf bird. The Waatch and Sooes Rivers and Mukkaw Bay estuary are important estuaries and salt marshes.

South of Flattery Rocks NWR is Quillayute Needles NWR. Critical marine mammal habitats located here include those for Steller sea lions, harbor seals, and sea otters. All bird species with critical habitats in Flattery Rocks NWR also have critcal habitats here. In addition, western grebe, double crested cormorant, Brandt's cormorant, white winged scoter, surf scoter, and Cassin's auklet have critical habitat here. Destruction Island is not part of this NWR but it provides critical habitat for seven bird species and two marine mammals species.

The Copalis NWR includes critical habitat for harbor seals and sea otters and the birds listed under Quillayute Needles NWR, with the exception of Cassin's auklet. An additional critical habitat is listed for the western gull.

Grays Harbor includes a large area of biologically rich tideflats and marsh. The bay helps support an ocean pink shrimp fishery. Also, Dungeness crabs are abundant and large portions of the harbor are classified as critical crab habitat. Fishes present include the English sole, starry flounder, green sturgeon, white sturgeon, and American shad. Black brandt, mallard pintail, American wigeon, canvas-back, glaucous winged gull, western gull, common murre, rhinoceros, and northern bald eagle are listed as having critical habitat here.

Three particularly important areas from Cape Flattery to Port Angeles are Neah Bay, Pysht River estuary, and Elwha River estuary. Neah Bay supports large populations of intertidal clams and abundant bottom fish. Harbor seals use the bay and Waadah Island in the bay is a critical haul out area for them (Washington Department of Ecology 1977b). The Pysht River estuary, about 30 miles west of Port Angeles, is a large estuarine system with extensive marsh, sand spits, sand flats, and a small lagoon. It is largely undisturbed and highly productive (Lindstedt-Siva 1978); clams, crabs, and waterfowl are abundant. Steelhead, cutthroat, and salmon run in the river. Low Point is critical habitat for harbor seals, who utilize it year round. Agate Bay and Tongue Point are critical habitat for Pacific herring and river otter, respectively. The Elwha River estuary, probably not as ecologically important as the Pysht, contains salt marshes, sand flats, and shallow channels which are important habitat for many invertebrates, fishes, and birds.

Port Angeles/Ediz Hook

The western portion of Port Angeles harbor and the area north of Ediz Hook have been designated a critical habitat for Pacific halibut during the spring and summer. Also, surf smelt spawn in the area. The area is an important resting and feeding area for birds (Washington Department of Ecology 1977). Subtidal and intertidal clams are abundant throughout the harbor. The southeastern portion of the harbor is noted as a major clam bed with an estimated site of 100 acres (Goodwin and Sawl 1978). Harbor seals and river otters are common here.

Green Point

Of 47 major hard shell clam beds listed by Goodwin and Shawl (February 1978). Green Point is second in area and third in estimated pounds of butter, littleneck, and horse clams. Goodwin (1978) lists 51 geoduck clam beds; two of which are off Green Point and rank first and third among the total list. Green Point accounts for 16 percent of the total populaton of geoduck clams in the Strait area. The area off Green Point is a critical habitat for Pacific halibut, during the spring, fall and winter, and for the red necked grebe. The terrestrial portions of the point are used by the endangered northern bald eagle (Washington Department of Ecology 1977b).

Dungeness Spit and Dungeness Bay

Like Cape Flattery, Dungeness Spit and Bay is a National Wildlife Refuge. The area is a critical habitat for surf smelt, Pacific halibut, river otter, harbor seal, black brandt, mallard, pintail, American wigeon, and canvas back ducks (Washington Department of Ecology 1977b).

The area from Dungeness to Sequim Bay is important for the species listed above and for western grebe, western Canada goose, white fronted goose, Barrow's goldeneye, buffle head, old squaw, white winged scoter, surf scote, greater scaup, rhinoceros auklet, least sand piper, dunliss, western sandpiper, sandesling, semi palmated plover and killdeer (Washington Department of Ecology, November 1977).

Goodwin and Sawl (1978) rank Dungeness Spit as the most important major hard shell clam bed in Puget Sound, based on estimated total clam weight. Based upon extent of area, the bed ranks third. Goodwin (1978) ranks Dungeness second out of 51 major geoduck beds, based upon both the total population estimate and size of the bed. Crabs and Pacific oysters (culture) also occur here as well as large numbers of octopus. In addition, Dungeness Spit and Bay provide extensive sand and mud flats, a large marsh and lagoon, and eel grass beds.

Marine Mammals

Several marine mammals occur in the Strait of Juan de Fuca, Strait of Georgia, and Puget Sound. For a detailed discussion see National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum, Environmental Research Laboratores (ERL) MESA, "Marine Mammals of Northern Puget Sound and the Strait of Juan de Fuca," January 1979 and the Washington Department of Ecology's "Washington Coastal Areas of Major Biological Significance," November 1977. There are five species of seals and sea lions, two species of otters, and 15 species of whales and porpoises. The four most abundant year-round residents are harbor seals, harbor porpoise, killer whales, and river otters. The Map Addendum illustrates the distribution of marine mammals.

California sea lion, Steller's sea lion (also called northern sea lion), northern fur seal, harbor seal, and northern elephant seal live in the area. Only the harbor seal is a year-round resident. Population estimates range from 1,600 (NOAA Technical Mem. 1979) to 5,460 (Washington Department of Ecology 1977b). Harbor seals are common throughout both the Strait and the Sound. During the winter, California and northern sea lions utilize Tatoosh Island and Cape Flattery, Sombrio Point and Race Rocks (Vancouver Island) and Lucia Island (San Juan Archipelago). Occasional sightings occur throughout the entire area. Elephant seals have been sighted in the Strait of Juan de Fuca, the San Juan Archipelago, and south of Seattle in Puget Sound. They are not abundant in any of these areas. Fur seals, once common in Washington waters, are sighted occasionally in the Strait and Sound.

Fifteen species of whales and porpoises are listed by the NOAA Technical Memorandum (1979) as occurring in Puget Sound and the Strait of Juan de Fuca. Four species are abundant: killer whales, harbor porpoises, minke whales, and dall porpoises. Populations of the first 2 species are fairly constant year round. The dall porpoise are present primarily during the spring and summer. Minke whales are sighted year round, but their utilization of the area is probably concentrated in the spring and summer. All of the remaining 11 species are uncommon. The white head grampus, false killer whale, pygmy sperm whale, north Pacific giant bottlenose whale, goose beak whale and the saddle back dolphin have been recorded on two or fewer occasions. The Pacific white-side dolphin is abundant on the outer coast and outer straits, but rare in the inner straits and Sound. Only seven have been sighted in Admiralty Inlet. Shortfin pilot whales are not common; only four have been reported off the outer coast and one in Hood canal.

Gray, fin, and humpback whales are all listed as endangered. The NOAA Tech. Mem. (1979) reports 59 sightings of 75 gray whales within the Strait and Sound between March 1976 and July 1978 (see Map Addendum). Fin whales, once an important species in this area, are now sighted occasionally in the Strait of Georgia. Humpbacks, like the fins, were once common in Washington waters. Two sightings have occurred in recent years near Seattle. Any gray, fin, or humpback whales occurring in inland waters should probably be considered strays.

River and sea otters occur here. River otters are abundant and apparently spend a great deal of their time in sea water. They are particularly abundant in the San Juan Archipelago, Saratoga Passage, Dungeness Bay, and Port Angeles (see Map Addendum). Sea otters, once abundant along the outer coast were hunted to near extinction and were eliminated from Washington waters around 1910. Fifty sea otters were released along the coast north of Grays Harbor in 1969 and 1970. The population remains very small; reports indicate there are only about 22 animals in Washington waters.

Threatened and Endangered Species

Gray, fin, and hump back whales are endangered species and have been discussed in the preceding section.

TERRESTRIAL VEGETATION

Ediz Hook is a specialized habitat that in its natural state would support "strand vegetation" similar to that on Dungeness Spit. Ediz Hook's present vegetation consists mainly of scattered grasses and beach plants along the inner margin of the spit and a better developed stand of these plants around the Coast Guard facility.

Green Point is within the western hemlock zone, but all forest land has been cut over and is now dominated by western red cedar, hemlock, grand fir, Douglas-fir and red alder in the overstory. The dense shrub understory is dominated by salal, rose, salmonberry and red elderberry (NTPC 1978). Repeated logging and poor logging residue disposal have apparently inhibited regeneration of Douglas-fir. The Green Point area is a medium quality site for Douglas-fir growth (Spitsbury and Smith 1947; Becking 1954).

Timber volume estimates for the commercially important species range from 10 to 30 thousand board feet per acre over the 242-acre site (NTPC 1978).

No threatened or endangered species or habitats have been identified at the onshore storage facility site or on Ediz Hook.

Area of Special Concern

Olympic National Park includes some of the world's finest examples of temperate rain forest, containing record specimens of several tree species as well as an unusual diversity of plants. Most of the park's dense coniferous forests are mature, undisturbed ecosystems remarkable for dense undergrowth of moss, fern, flowering plants, and lichen. The diverse lichen population largely consists of air pollution-sensitive types.

The entire park has been designated a biosphere reserve. Biosphere reserves are elements of a United Nations program (Franklin and Dyrness 1977) primarily aimed at preserving areas representative of major biotic diversions of the world for the purpose of conservation of natural ecosystems and the genetic material they contain, research and monitoring, and education.

Olympic National Park Headquarters in Port Angeles is located 3 miles south southeast of the proposed port at Ediz Hook and is connected to the park by a 4-mile-long parkway. The Green Point site is 6.5 miles east northeast of the park boundary.

TERRESTRIAL WILDLIFE

Threatened and Endangered Species

At least four bald eagles use the tall snags and open branched confiers on the site of the proposed onshore storage facility as a roosting area. Two adults and three immature birds were found commonly in the area from late December 1978 through March 1979; at least four bald eagles were frequently observed during February 1978. The bald eagle roosts are surrounded by dense vegetation obscuring the eagle's vision of human disturbance and residences.

The Green Point area contains wintering and potential nesting habitat. The salmon run from mid-September through January up Siebert Creek provides a winter food source. Eagles also scavenge for fish and ducks along the open, privately owned beach which has been kept relatively undisturbed. The Enforcement Division of Fish and Wildlife Service had officially designated one site on Green Point as an active bald eagle nest. High winds in February 1978 partially destroyed this nest and it was not rebuilt in spring 1979 although breeding behavior was observed. A second nest exists near Monterra, 2 miles east of Green Point and may be an alternate nesting site. Bald eagles are known to reoccupy a nest unused for several years and frequently use alternate nest sites (FWS Bald Eagle Management Guidelines ORE-WA and Carol Snow).

No threatened or endangered terrestrial mammals have been identified at either Ediz Hook or Green Point.

Other Species

Ten mammal species have been confirmed in the Green Point area, including vagrant shrew, deer mouse, jumping mouse, mountain beaver, Townsend's chipmunk, Douglas squirrel, racoon, ermine, black bear, and mule deer (NTPC 1978). Spring field surveys documented the presence of 48 bird species (NTPC 1978), the majority being common species characteristic of the Olympic Peninsula (NTPC 1978). These include Bewick's wren, black-throated gray warbler, orange-crowned warbler, American goldfinch, and song sparrow. Three game species were identified: California quail, band-tailed pigeon, and ruffed grouse. Ruffed grouse are present in relatively high numbers (NTPC 1978). The common garter snake, northwestern garter snake, Pacific tree frog, red-legged frog, and Pacific coast newt were also found on the site. Waterfowl associated with Port Angeles and adjacent areas were addressed above in the marine section.

CULTURAL RESOURCES

Cultural resources include buildings, sites, objects, works of art, and other human modifications of the natural environment. By their nature, cultural resources are fragile, finite in number, irreplaceable, and nonrenewable. Each cultural resource is a record of human activity. Most archaeological sites--prehistoric and historic--are difficult to observe, usually buried, often covered by vegetation, and not necessarily located in areas that seem to be obvious places for past or present human activity. Most historical sites, while more easily observed, have not been identified, recorded, or evaluated. Paleontological resources, as a unique record of nonhuman life, are also discussed. The locations of most paleontological and cultural resource sites are not currently known. Areas of potential impact have not been systematically investigated with the objective of identifying cultural resource sites.

Archaeological and Historical Resources

The National Register of Historic Places (USDI, Heritage Conservation and Recreation Service 1979) and monthly supplements through June 5, 1979, indicate no sites currently listed in or eligible for inclusion in the Register located in the port or storage facility areas. A number of cultural resource sites have been identified in Port Angeles. The Washington State Register includes the Clallam County courthouse, the Clallam Indian Village site on Hollywood Beach, the Puget Sound Cooperative Colony, and the Ediz Hook Light Station site, consisting of the ruins of the 1908 and perhaps the 1865 lighthouse buildings. Port Angeles Harbor, the original Port Angeles townsite, Mt. Angeles Cemetery, Ocean View Cemetery, Lincoln Park, the Clallam County Fairgrounds, the Beaumont Cabin, Olympic Hotel, Masonic Temple, Congregational Church, and St. Andrews Episcopal Church are historic sites whose significance has not yet been officially evaluated.

There are no currently known cultural resource sites located in the onshore storage facility area. There is potential for discovery of historical and archaeological sites in both the port and storage facility areas.

Paleontological Resources

No currently known fossil sites are located in the areas of potential impact. Tertiary and Pleistocene fossils are known from deposits within several miles of the proposed storage facility site. Similar deposits may exist at Green Point and thus there is potential for discovery of paleontological material in the project area.

VISUAL RESOURCES

Evaluation of scenic quality involves descriptions of landforms, vegetation patterns, water features, and man-made structures and alterations. A rating of A/B or C is assigned, as determined by a modified version of the Bureau of Land Management's visual resource management system. A more complete discussion of the visual management system is presented in the discussion of visual resources in the Pipeline System section of this chapter.

Visual sensitivity of a landscape is determined in part by the viewer's distance from the site. A location within 5 miles of a project site would be within the foreground-middleground visual zone; 5-15 miles from a site would be in a background visual zone.

The site of the proposed port is characterized by the simplicity of the horizontal form of Ediz Hook contrasted to the complexity of the urban Port Angeles landscape.

Low profile structures on Ediz Hook include the U.S. Coast Guard Air Station, the Puget Sound Pilot's Association facility, a small marina, and an overhead utility line. There are also offshore pilings, log booming areas, and a floating chip container. Views from Port Angeles are often dominated by harbor traffic that includes tankers, freighters, tugboats, a passenger ferry, and small recreational craft.

Within 1.5 miles offshore of the proposed port site, views are restricted to those from passing vessels. Shoreline facilities and the northern limits of the Port Angeles business district are approximately 1.5 miles from the proposed port site. Views are generally unobstructed. Heavily traveled U.S. Highway 101 passes through Port Angeles. Views of the proposed port area are partially obscured by structures and vegetation. Residential areas extend about 3 miles to the south over gradually rising terrain, increasing visibility of the harbor. For observers at all of these points the proposed port site would be in the foreground-middleground visual zone.

The proposed site for the onshore storage facility at Green Point is at present heavily wooded and undeveloped except for a narrow gravel road. The terrain is flat to gently north sloping, with vegetation reaching heights of 60 feet. The surrounding area varies from undeveloped woodland to wooded suburban residential sites and open agricultural land. Significant views of the Green Point site are primarily from a small residential area to the west, a larger agricultural area to the east, and from offshore.

The entire shoreline from Green Point to Port Angeles is in a foreground-middleground zone for all observers on the Strait of Juan de Fuca. Beyond 3 miles, visibility is often restricted by climatic conditions, but weather permitting, both shorelines can be viewed from ships as far as 5 miles out in the strait. The entire shoreline is visually sensitive in the background zone as well as foreground-middleground. The scenic quality, unique atmosphere, and "port life" in the harbor and on the Hook, gives scenic value of moderate to high or A/B rating.

LAND USE

This section discusses land ownership and land use at and near the proposed port and onshore storage facility. Lands with special management concerns including Native American and wilderness areas are also discussed. The order of discussion proceeds from Port Angeles Harbor and the city of Port Angeles, to Clallam County, and lands adjacent to the Strait of Juan de Fuca.

An overview of current land use within a 10-mile radius of the proposed port and the onshore storage facility is shown in figure 2.1-11. The following narrative supplements this figure and will refer to more detailed maps in of the Map Addendum.

Port Angeles Harbor

The general arrangement of Port Angeles harbor is illustrated in the Map Addendum. The harbor is 2.7 nautical miles long and 1.4 nautical miles wide at the entrance and is bounded by the mainland on the south and southwest, by Ediz Hook on the north and northwest, and by an open strait to the east.

Ownership

Within the harbor, tideland and harbor areas not more than 2,000 feet from shore are administered by the Washington State Department of Natural Resources (DNR). The DNR has sought to accommodate existing users as well as the needs of NTPC if their proposal is approved. For the portions of the tideland and harbor areas proposed for the NTPC facilities, the DNR is reissuing 10-year leases to wood product firms with the reservation that the leases can be cancelled during the first year for paramount public need. The lease terms were the result of two meetings and negotiations between the lessees and the DNR.

Existing Uses

Port Angeles Harbor is used for industrial, recreational, commercial fishing, and transportation purposes. The principal industrial use of the harbor is log rafting, sorting, and storage in conjunction with wood product firms located around the harbor. These uses are illustrated in the Map Addendum. Most of the DNR lease areas near the base of and outward along Ediz Hook are used for log storage. The proposed port would occupy about 55 percent or 110 acres of the lease areas currently used for log storage by Crown Zellerbach and ITT Rayonier. An adjacent lease area is occupied by Foss Launch and Tug Company.

Additional uses within the proposed NTPC lease area include the Thunderbird Marina and the Puget Sound Pilot's Association Pilot Boat Station.

Transportation and recreational uses of the harbor are described later in this chapter.

Other Uses

The U.S. Coast Guard operates an air-sea rescue station at the east end of Ediz Hook. Facilities at the station include a runway for aircraft and a boat dock on the harbor side of the hook. U.S. Coast Guard is in the process of a $2.5 million improvement project at the air station.

The Federal Aviation Agency (FAA) operates a Vertical Omnirange (VOR) air navigation site, located on the Coast Guard property.

City of Port Angeles

Land Ownership and Existing Land Use

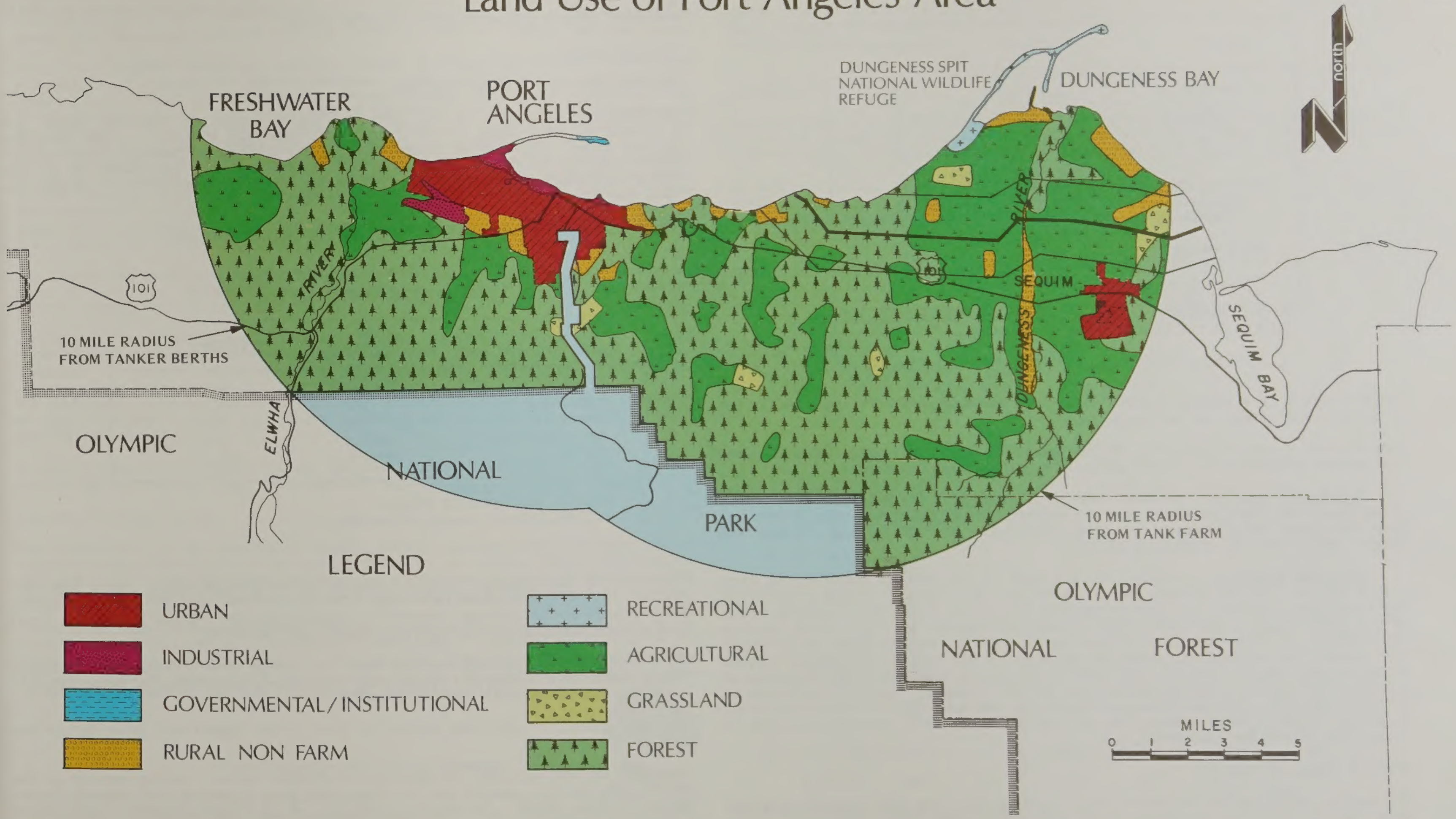
Public and private ownership and land use patterns within the city of Port Angeles are shown in table 2.1-19. Existing land use characteristics of the five neighborhoods identified in the 1976 Port Angeles Comprehensive Plan are shown in the Map Addendum.

Neighborhood A is 74 percent vacant land and has just recently begun to develop. Housing is primarily single family and low density. The industrially zoned land is predominantly vacant.

Neighborhood B is developing into a residential neighborhood. Transportation is difficult due to ravines and large institutional land uses. There is a stable commercial strip along C Street. Parks are presently adequate and are expected to remain so.

Neighborhood C is the oldest and densest core of the city and contains the historic downtown. It has traffic circulation problems. The commercial strip along Lincoln Street is becoming the major daily shopping area of the neighborhood and the city. An institutional use area is developing east of the Lincoln Street commercial strip. The hospital is a major element in this section of the neighborhood.

Land Use of Port Angeles Area



Source: BLM

Figure 2.1-11

TABLE 2.1-19 SUMMARY OF 1973 LAND USE INVENTORY FOR THE CITY OF PORT ANGELES

Category	Acreage	Percentage
Residential	1,170	22
Commercial	107	2
Industrial	300	6
Public	652	12
Streets	865	16
Total buildup	3,094	59
Buildable vacant	2,051	39
Unbuildable vacant	120	2
Total vacant	2,171	41
Total area	5,265	100

Source: Adapted from Port Angeles Comprehensive Plan 1977
(Figures do not total because of rounding.)

Neighborhood D is a rapidly growing urban-suburban-rural area. It lacks sufficient arterial street access and has few parks.

Neighborhood E consists of older single family dwellings and vacant land, blending old and new single-family housing areas. The neighborhood lacks parks.

Industrial Land Use. Existing industrial uses within the city are concentrated along the harbor, Ediz Hook, and near the airport. Major industrial uses include two pulp and paper mills operated by Crown Zellerbach and ITT Rayonier, lumber and plywood mills, and fish processing plants.

Ediz Hook Ownership. Property at the base of the hook is owned by the city and leased to Crown Zellerbach and ITT Rayonier. From the city-owned property to the Coast Guard Station, the land is owned by the United States under administration of the Coast Guard. The Coast Guard leases the land to the city, which in turn subleases to private firms. The lease areas directly onshore from the proposed NTPC marine facility are subleased by the city to ITT Rayonier (Peninsula Plywood Division) and Crown Zellerbach. The latter subleases to the Salmon Club Incorporated which in turn subleases to the Thunderbird Marina. Terms of the city's subleases to both ITT Rayonier and Crown Zellerbach extend to the year 2013. The proposal would occupy 4.3 acres of these leased areas for access and parking. Property ownership is illustrated in the Map Addendum.

Land Use Plans and Zoning

The Energy Facility Site Evaluation Council (EFSEC) has determined that the proposed port facility would be consistent with the Port Angeles "heavy industry" zoning designation and the comprehensive plan.

The shoreline master program designation for Port Angeles harbor is "urban environment." The use regulations pertinent to this designation allow for industrial wharfs and piers subject to environmental considerations.

Clallam County

Land Ownership and Existing Land Use

Approximately 48 percent of all land in Clallam County is federally owned, and 6 percent is state-owned. Private and local ownership accounts for the remaining 513,500 acres. The Clallam County Governmental Conference "Housing Inventory and Impact Baseline Data" report of June 1977 further excludes land owned by private timber concerns in concluding that 11 percent, or 130,000 acres, is available for development.

Existing land use in Clallam County is displayed in table 2.1-20.

TABLE 2.1-20 CLALLAM COUNTY LAND USE

Use	Acres	Percent
Residential	13,660	1.2
Industrial	650	-
Commercial	157	-
Agricultural 1/	64,092	5.7
Timber 2/	999,898	89.1

Source: Arthur D. Little 1977
1/ Includes small private forests.
2/ Includes federal, state, and private.

Figure 2.1-11 shows land use within a 10-mile radius of Green Point. Aside from Port Angeles, the only urban area is Sequim. The agricultural land between Port Angeles and Sequim is gradually being converted to residential use. Within the county, total farm acreage declined about 11 percent between 1969 and 1974.

The proposed onshore storage facility would be located on a site occupied by second growth timber in a low density residential development. A residential subdivision is being developed immediately west of the site.

Intensive shoreline land uses within the Puget Sound region are shown in the Map Addendum.

Two landfills are currently in operation in Clallam County. One is located at the western edge of Port Agneles and the other near Lake Creek and U.S. Highway 101 in western Clallam County. For further discussion of solid waste disposal, see section 2.1, Social Conditions.

Special Management Areas

Lands with special management concerns within Clallam County include Native American areas, the Dungeness National Wildlife Preserve, and the Olympic National Park.

None of the proposed facilities would be located on Indian Reservations. However the proposal is of interest to Native Americans. Tankers traveling to and from Port Angeles Harbor would pass offshore of the Makah Indian Reservation at Neah Bay and the Reservation of the Lower Elwha Band of the Clallam Tribe near Port Angeles (see Map Addendum). The Lower Elwha Reservation occupies 500 acres about 5 miles west of Port Angeles on the Lower Elwha River. Areas outside of these reservations may still be of particular interest to Native Americans. Treaties with the Pacific Northwest Indian tribes signed from 1853 to 1864 generally assured Native Americans the right to fish upon the reservations and all other "usual and accustomed stations in common with citizens of the United States." These "usual and accustomed stations" were not specified in the treaties and their locations remain a matter for factual determination (Pacific Northwest River Basin Commission 1970).

The Olympic National Park headquarters is located in Port Angeles, a primary entry point to the park. Except for small areas near the boundary, which are managed for general recreation, the park (908,692 acres) is proposed for wilderness designation.

The proposed port and onshore storage facilities would therefore be within 7 to 8 miles of the wilderness boundary. The Dungeness National Wildlife Refuge (see Map Addendum) is about 5 miles northeast of the proposed onshore storage facility.

The Washington Environmental Atlas indicates a proposed research or educational area at Slip Point near Clallam Bay, located on the Strait of Juan de Fuca about 40 miles west of Port Angeles.

Across the Strait in Canada, along the west coast of Vancouver Island, are the Pacific Rim and proposed west coast national parks.

Land Use Plans and Zoning

The Energy Facility Site Evaluation Council (EFSEC) has determined that the proposed onshore storage facility would be inconsistent with the Clallam County comprehensive plan and zoning which designated the area for residential and agricultural uses. The implications of EFSEC's determination are further discussed in chapter 1.

The Clallam County Shoreline Master Program designates the shoreline adjacent to the onshore storage facility as a "conservancy environment." The NTPC application to the EFSEC concludes that construction of the submarine pipeline to the onshore storage facility would be inconsistent with a number of use regulations pertinent to construction of a utility and construction near shoreline cliffs.

TRANSPORTATION AND UTILITY NETWORKS

This section describes inland water, highway, rail, and air transport networks in the vicinity of the proposed port and onshore storage facilities. The electric transmission network will also be discussed. Local water and sewer networks are addressed in the social section which follows.

Inland Water Transport

Vessel traffic for Port Angeles Harbor is shown in table 2.1-21. A large portion of harbor traffic is log rafting (table 2.1-22) and a regular ferry service to Victoria, British Columbia.

Oil tankers may lay over for several days while waiting for berths at Cherry Point and Anacortes.

Existing piers within Port Angeles harbor are shown on table 2.1-23 and illustrated in the Map Addendum. Pier numbers begin with the ITT Rayonier plant on the east shore of the harbor and proceed clockwise along the shore and out Ediz Hook.

In addition to the vessel, raft, and ferry traffic shown, a large share of harbor traffic consists of commercial fishing and recreational boating. Vessel activity in the Strait of Juan de Fuca is described later in this chapter.

TABLE 2.1-21 PORT ANGELES HARBOR VESSEL ARRIVALS (1977)1/

	Self Propelled Vessels			Non-Self Propelled Vessels		Total
Draft (feet)	Passenger and Dry Cargo	Tanker	Towboat	Dry Cargo	Tanker	
39		7				7
38						0
37						0
36	2					2
35	2					2
34		1				1
33						0
32		3				3
31		1				1
30	2					2
29	4					4
28	3	2				5
27	4					4
26	3					3
25	4					4
24	2					2
23	14	1				15
22	16					16
21	13					13
20	17					17
19	15		2		1	18
18						0
and less	144		2,427	670	151	3,392
Total	245	16	2,429	670	152	3,512

Source: Corps of Engineers 1977

1/ Excludes domestic fishing craft and ferry service.

TABLE 2.1-22 PORT ANGELES HARBOR TRAFFIC (Short Tons)

Vessel Year	Traffic	Rafted	Total
1967	1,447,341	1,334,559	2,811,900
1968	1,711,761	1,274,684	2,986,445
1969	1,665,975	1,270,875	2,886,850
1970	1,804,719	874,631	2,679,350
1971	1,753,352	827,512	2,580,864
1972	2,149,712	699,409	2,849,121
1973	2,348,688	370,097	2,918,785
1974	2,116,200	873,419	2,989,619
1975	2,196,701	329,812	2,726,513
1976	3,050,214	191,254	3,241,468
1977	2,854,789	428,223	3,283,012

Source: Corps of Engineers 1977

Passengers waiting for Port Angeles-Victoria ferry Coho on Black Star dock

The Port Angeles Daily News

TABLE 2.1-23 PORT ANGELES HARBOR PIERS AND OPERATIONS

Pier No.	Operator	Principal Use
1	ITT Rayonier Inc.	Cargo: shipping wood pulp
2	ITT Rayonier Inc.	Receipt of fuel oil by tanker
3	ITT Rayonier Inc.	Shipment of baled wood pulp
4	ITT Rayonier Inc.	Receipt of wood chips, limestone
5	ITT Rayonier Inc.	Receipt/shipment of rafted logs
6	City of Port Angeles	Multi-purpose
7	Peter Pan Seafoods, Inc.	Receipt of fish
8	Angeles Gravel & Supply Company, Inc.	Receipt of sand and gravel
9	Black Ball Transport Inc.	Passenger Ferry
10	General Construction Company	Mooring equipment
11	Foss Launch & Tug	Mooring tugs
12	Imperial Crown Seafood	Receipt of fish
13	Peninsula Plywood Corp.	Receipt/shipment of rafted logs
14	Peninsula Plywood Corp	Shipment of wood chips
15	Port of Port Angeles	Cargo shipment/receipt
16	Port of Port Angeles	Cargo shipment/receipt
17	Chevron Oil, Texaco, ARCO, D&D Distributors	Receipt of petroleum products
18	Port of Port Angeles	Placing logs into water for shipment by raft
19	M&R Timber, Inc.	Shipment of lumber
20	M&R Timber, Inc.	Shipment of logs
21	M&R Timber, Inc.	Shipment of woodchips
22	M&R Timber, Inc.	Shipment of sawdust
23	Crown Zellerbach Corp.	Receipt of logs
24	Crown Zellerbach Corp.	Receipt of pulp, chips
25	Crown Zellerbach Corp.	Receipt of fuel oil; shipment of newsprint
26	Crown Zellerbach Corp.	Mooring of supplies
27	Crown Zellerbach Corp.	Mooring of boats
28	Peninsula Plywood Corp.	Placing of logs into water from trucks for log rafting
29	Puget Sound Pilots Assoc.	Mooring harbor pilot boats
30	U.S. Coast Guard	Mooring vessels

Source: Corps of Engineers 1975

Road and Highway Networks

U.S. Highway 101 is the principal route within Clallam County to Port Angeles. Average daily traffic in 1976 for U.S. Highway 101 in this vicinity was 17,400 vehicles. As an average figure, this does not indicate summer weekend peak traffic that results from tourism.

The only road access to Ediz Hook is via Marine Drive and the city streets of Port Angeles. At Green Point, access is via Old Highway 101, which is now a county maintained two-lane highway, primarily serving local traffic.

Traffic flow on streets and highways is defined by level of service, shown in table 2.1-24. Levels of service are also measured in terms of volume per capacity ratios. Roadway capacities would occur at level of service "E", while level of service "C" is considered a desirable design level. The following is a brief description of existing service levels within the project area as shown in figure 2.1-12.

TABLE 2.1-24 LEVEL OF SERVICE CHARACTERISTICS FOR STREETS AND HIGHWAYS

Level of Service	Description	Average Overall Speed			
		Four-Lane Undivided Highway With no Access Control	Two-Lane Highway	Urban and Suburban Arterial Streets	Downtown Streets
A	Free flow; some stops on downtown streets	-	-	30+	25+
B	Stable flow; upper speed range on highways; slight delays on streets	55+	50+	25-29	20-24
C	Stable flow; acceptable delays	45-54	40-49	20-24	15-19
D	Approaching unstable flow; tolerable delays	35-44	35-39	15-19	10-14
E	Unstable flow; congestion; intolerable delay	About 30	About 30	About 15	Below 10, but moving
F	Forced flow	Below 30	Below 30	Under 15	Stop and go

Source: Adapted from National Academy of Sciences 1965

U.S. Highway 101 passes through the downtown areas of both Sequim and Port Angeles. Between these two urban areas, the highway has two- and four-lane sections. The four lane section east of Port Angeles is presently being extended eastward to the intersection with the old Olympic Highway. Those portions of U.S. Highway 101, nearest to Port Angeles and Sequim frequently provide levels of service at or below level "C". Within Port Angeles a 1973 traffic study (Harstad 1973) found that many downtown streets provided levels of service below "C" during evening peak travel periods. Although many improvements recommended in the report have been implemented, increases in traffic volumes have kept service levels at about the same levels as reported in 1973.

A high proportion of truck and summer tourist traffic contributes to reduced levels of service on both Port Angeles streets and on U.S. Highway 101. Marine Drive, providing access to Ediz Hook, is constricted by numerous railroad tracks and the Crown Zellerbach plant.

Review of traffic volume data from 1973 through 1976 indicates traffic volumes on U.S. Highway 101 have increased more in rural areas east and west of Port Angeles than within the city. The average traffic volume grows 1.5 percent per year within the city and 3.5 percent in rural areas (NTPC 1978).

In early 1979 the Hood Canal bridge collapsed during a storm. The bridge, with a 1976 average daily traffic count of 4,977 (Washington State Highway Commission 1976) connected Kitsap and Jefferson counties. Traffic between communities such as Port Angeles and Bremerton must now be routed around Hood Canal rather than crossing over it.

Railroads

The Port Angeles-Clallam County area is served by the Milwaukee Railroad. The line crosses Puget Sound from Seattle to Port Townsend by barge and continues to the Port Angeles harbor area, traversing the southern boundary of the proposed onshore storage facility. The future of this branch line is under study by both the railroad and the U.S. Department of Transportation. Current use is one train per day in both directions. Although the line is satisfactory for current use, the need for expensive rehabilitation is anticipated, including a new barge and slip at Port Townsend.

Air Transport

The William R. Fairchild International Airport at Port Angeles is a commuter service general utility airport. An airport in this category is regularly served by one or more carriers not certified by the Civil Aeronautics Board, and handle 2,500 or more passengers a year. Total operations (landings and takeoffs) for 1976 were 72,000, roughly a third of the airport's estimated capacity (U.S. Department of Transportation 1977).

Electric Transmission

The principal source of electric power for Clallam County and Port Angeles is the Bonneville Power Administration (BPA). BPA service is via a 230-kV transmission line and a 115-kV line.

The proposed port facility is within the service area of the Port Angeles City Light and Power Department. An existing substation with 69-kV service is located near the base of Ediz Hook, with a single circuit overhead distribution line on Ediz Hook. This line is inadequate to serve the proposed port facility. The proposed onshore storage facility is within the Clallam County Public Utility District Service Area which has 69-KV service within 1 mile.

Port Angeles Area – Annual Average Daily Traffic (1976)

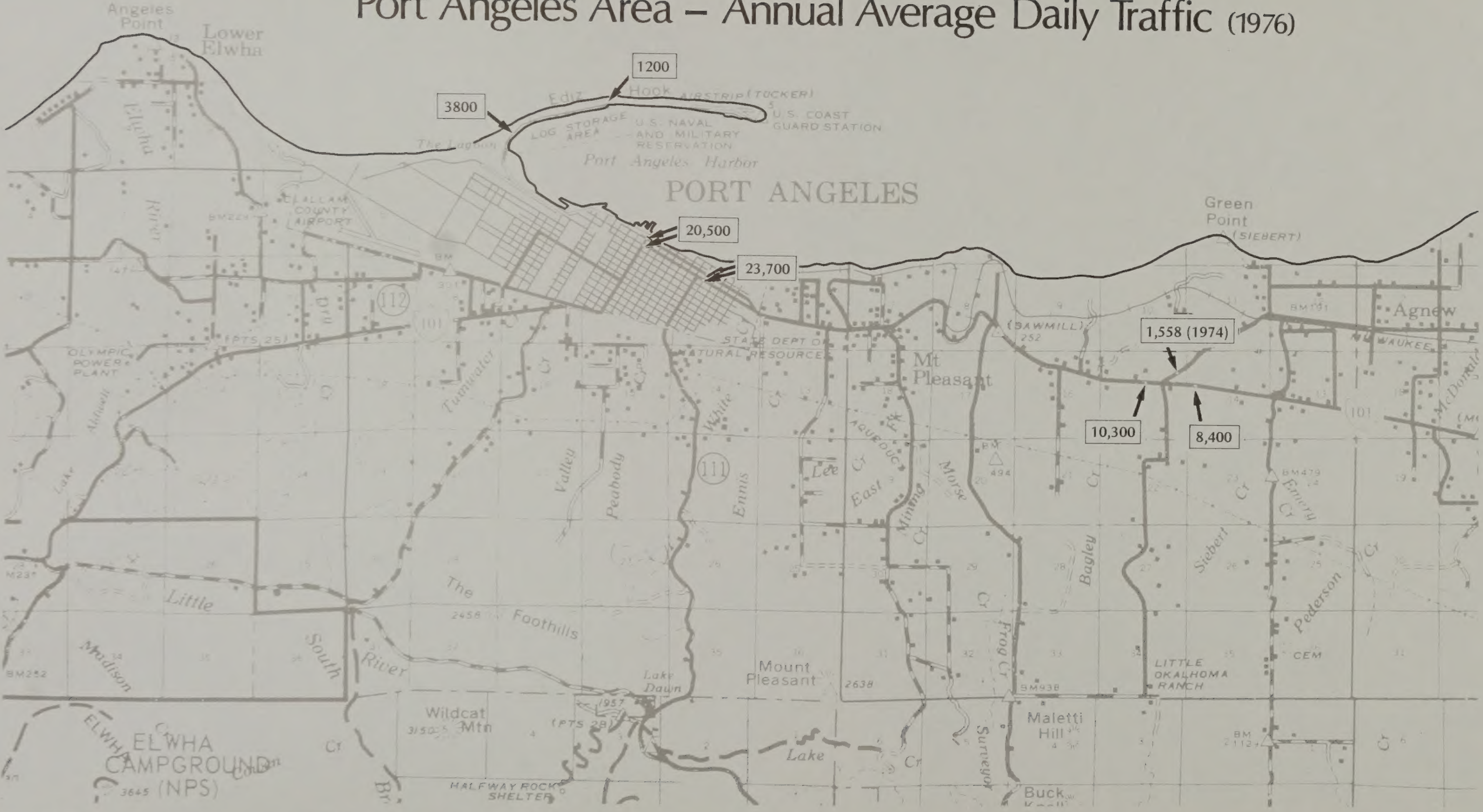


Figure 2.1-12 Sources; Washington Department of Highways, Annual Traffic Report - 1976 E.R.T. - 1978 (Data in original mislabeled 1978).

Power supply is an exceedingly complex issue in this region. Presently, the public utility departments of Port Angeles and Clallam county purchase most of their electrical power from BPA. Their existing contracts with BPA expire at the end of 1984 and 1985 respectively.

In 1976, BPA gave notice they will no longer have sufficient firm energy to supply the load growth of their customers after July 1, 1983. After that date, power supplied to BPA's preference customers, which includes the Port Angeles and Clallam county utilities, will be based on an allocation system stated in existing contracts. BPA is currently developing a new allocation formula. This new formula will be used in new power sales contracts to allocate BPA's firm energy.

In anticipation of a power supply shortage, the Port Angeles and Clallam county utilities have contracted power from Washington Public Power Supply System nuclear units 4 and 5. Construction of these units has been delayed and power will not be available from them until at least 1985 or 1986.

Current forecasts of regional electrical power availability indicate there might be shortages based on critical water year conditions, in any year from the present through the 1980s. A critical water year is considered to occur 1 year in 10. Most power marketed by BPA is produced hydroelectrically. Given the possibility of regional power supply shortages, local utilities are limited in their ability to meet new load growth.

Table 2.1-25 shows present and forecasted loads for Port Angeles City Light Department and Clallam County Public Utility District (PUD).

TABLE 2.1-25 PORT ANGELES AND CLALLAM COUNTY ELECTRICAL LOADS IN MEGAWATTS

Utility	Present (1977) Loads Average1/	Present (1977) Loads Peak	Forecasted Loads 1981 Average	Forecasted Loads 1981 Peak	Forecasted Loads 1985 Average	Forecasted Loads 1985 Peak
Port Angeles City Light Department	67.7	138.0	103.4	155.9	108.6	168.0
Clallam County Public Utilities District	44.2	105.7	58.0	132.5	72.8	165.9

Sources: Present loads, NTPC 1978; forecasted loads, BPA 1978

1/ Average load calculated from energy sales data and does not include transmission losses.

RECREATION

Recreational boat ownership in Puget Sound is the highest per capita in the United States. Estimates of total recreational boats in Washington range from 360,000 to 420,000.

Millions of recreationists visit the shoreline parks in Puget Sound, along the Strait, and Pacific coastline. Tourists contributed close to $2 billion in 1977 to Puget Sound and Strait counties (Washington Department of Commerce and Economic Development, pers. comm. 1979).

Studies (see chapter 3) have determined that the Pacific coast, Strait, and Sound could be affected by a marine oil spill. These areas will be included in the following discussion.

Marine Related Recreation

Pleasure boating, sport fishing, shellfish collecting, nature related viewing and photography, and day use of shoreline parks are the most important marine related recreation.

Moorage space for pleasure boats throughout Puget Sound and the Strait is insufficient to maintain current demand; most marinas have a waiting list. In Port Angeles, the largest marina has been operating at capacity (555 boats) for several years with a waiting list of 264. Approximately 200 boats are full time commercial fishing vessels and the remainder are used for recreation.

On Ediz Hook, the Thunderbird marina operates between April and October. This small marina has a capacity for 48 recreational and 2 charter boats. Demand for moorage in Port Angeles is high. Boats are drydocked or trailored due to lack of available moorage.

Sport marine salmon fishing is the most significant recreational fishery in the Pacific Northwest. In 1977, the sport salmon catch for Washington was almost 1.1 million. More than half of all sport salmon (63 percent) were caught along the Pacific coastline between Grays Harbor and Cape Flattery. The central Puget Sound was of secondary importance (19 percent of the total sport catch). Catch success for this area is twice the average of all other areas fished for marine salmon (Washington Department of Fisheries, pers. comm. 1979). Distribution of sport salmon fishing areas is shown on the marine resources maps in the Map Addendum.

Sports fishing out of Port Angeles is of local and regional importance. Limited data indicate that 20,000 marine angler starts occurred off the public launching facility on Ediz Hook in 1977 (Washington Department of Fisheries, pers. comm. 1978). Most fishing is for salmon. Monthly fishing contests during the summer and an annual Salmon Derby which attracted more than 6,000 entrants in 1978 are of local and regional significance. Many smaller local derbies are scheduled each summer.

Ediz Hook is the focal point for fishing activity in Port Angeles. It provides protection for winter sports salmon anglers; approximately 4,000 anglers set our from the public launching facility between November 1966 and March 1977 (Washington Department of Fisheries, pers. comm. 1978).

Non-salmon sports fisheries are generally for bottom or rock fish. Central Puget Sound is the most important area for the total recreational bottomfish catch (66 percent of all catch) with the area off Grays Harbor of secondary importance (Washington Department of Fisheries, pers. comm. 1979). In 1977, more than 900,000 bottomfish were caught by sport anglers compared to more than 700,000 in 1976. Albacore tuna fishing occurs primarily outside Westport on the Pacific Coast. Approximately 4,200 albacore were caught by sport anglers in 1977. Distribution of bottomfish areas is shown in the Map Addendum.

Shellfish collecting is an important aspect of recreation in the Northwest. Although Washington has 2,685 miles of saltwater shoreline, more than 50 percent is privately owned and inaccessible to the public. Of the remainder, only 18 percent of Puget Sound, the Strait, and Hood Canal is accessible to the public for shellfish collection or other shoreline activities. Most areas experience capacity use levels during the summer season.

Extensive razor clam beaches along the Pacific coastline from Grays Harbor north have limited highway accessibility; cars are allowed on the beach. According to the U.S. Fish and Wildlife Service (1979), the beaches between Taholah and Grays Harbor have the highest concentration of razor-clam diggers in the state.

Charter trips to observe sea birds or watch the whale migrations in the Strait are attracting more recreationists. Two main tour groups are involved in this effort. Wildlife viewers, photographers, beach combers, campers and shoreline park visitors form another significant recreation group.

Total current recreational use of shoreline parks and casual activities related to the marine environment is unavailable.

TABLE 2.1-26 RECREATION USE IN NW WASHINGTON SHORELINE PARKS

Area	Number of Visits	Year
DAY USE		
Dungeness Refuge and Recreation Area	115,000	1978
Salt Creek County Recreation Area (Crescent Bay)	159,000	1978
Deception Pass State Park (Whidbey Island)	2,143,236	1978
Moran State Park (Whidbey Island)	150,000	1978
San Juan County (all state parks)	1,490,400	1975
Hoh River to Lake Ozettc Hiking Trails	237,000	1978
OVERNIGHT CAMP USE		
Olympic National Park (3 coastal campgrounds)	181,616	1977
San Juan County (major shoreline campgrounds)	46,000	1978

Source: Washington State Parks personal comm. 1979
Olympic National Park personal comm. 1979
Clallam County personal comm. 1979

Casual recreational use of the Port Angeles waterfront and Ediz Hook is locally important. The variety of international boats using the harbor, an underwater scuba diving park off the end of the Hook, the many kinds of waterfowl and marine mammals, as well as accessibility for boat launches, combine to attract an average of 1,000 recreational car visits per day during the summer (U.S. Army Corps of Engineers 1976). Figure 2.1-13 illustrates the proximity of recreational activities in Port Angeles Harbor.

Ferry service to Victoria, British Columbia, departs from the harbor. Over 850 trips departed in 1978 carrying approximately one-half million round trip passengers. Peak use of the ferry is between May and September when four departures occur daily. Use during the rest of the year is low. For example in August, 1978, a peak of 122,073 people rode the ferry as compared to 9,615 passengers in December 1978. The Black Ball Ferry also carries vehicles. In 1978, over 120,000 vehicles (not including bicycles) were transported between Port Angeles and Victoria (Black Ball Ferry, pers. comm. 1979).

Non-Marine Recreation and Tourism

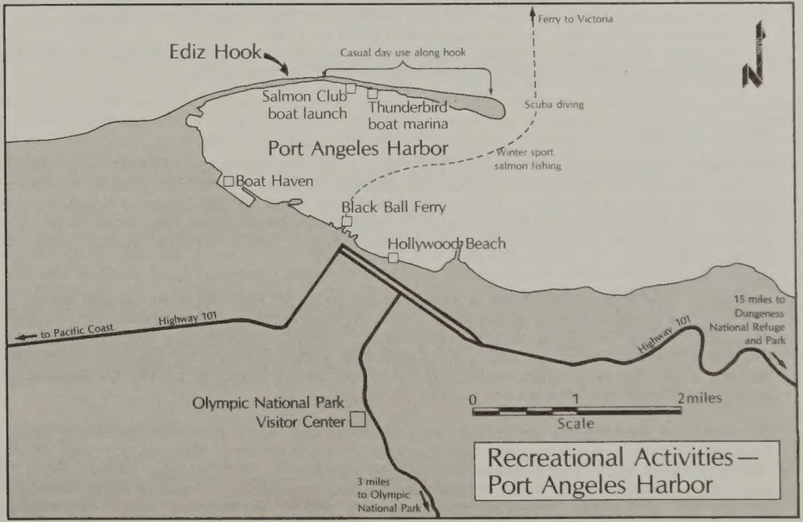
Use of the Olympic National Park, area tourism, and visits to Port Angeles enroute to Victoria are other forms of recreation in the area. The Olympic National Park is one of the most heavily used parks in the national park system. For example, 1978 visitor use of the Olympic National Park exceeded that for Grand Canyon, Yosemite, or Yellowstone National parks (National Park Service, pers. comm. 1979). Use is seasonal; 80 percent of park use occurs between April and September. Port Angeles is the major road entry point to the park's high country.

The Heart O'the Hills road leads 18 miles from Port Angeles to Hurricane Ridge with outstanding views into the inner Olympic Mountains. Several vista points along the road also provide sweeping views across the lowlands, the Strait of Juan de Fuca, and into Canada. A total of 862,139 acres of the 908,692-acre park have been proposed for addition to the National Wilderness System.

The entire Olympic Peninsula attracts tourism. Port Angeles is the largest coastal city with services to accommodate numbers of tourists. It provides access and services to those with overnight or extended visits to the Olympic National Park. Port Angeles is also a point of ferry departure for Victoria, British Columbia, as previously discussed.

Estimates by the Washington Department of Commerce and Economic Development indicate that tourism has increased 24 percent between 1976 and 1977 in Clallam county. Extrapolating from lodging receipts, they estimated that $83.3 million accrued to Clallam county from tourist expenditures. Locally, Port Angeles depends heavily upon summer tourist and national park visitation. According to the Stanford Research Institute (1978), up to 20 percent of the employment on the Olympic Peninsula is directly or indirectly dependent upon the Olympic National Park. The most popular entrance to the park is the Heart O'The Hills, approximately 4 miles from Port Angeles.

Lake Fisherman



Recreational Activities—Port Angeles Harbor

Figure 2.1-13

Strait of Juan de Fuca

The Strait of Juan de Fuca is the principal entrance to Puget Sound and the inland waters of lower British Columbia. About 260,000 people live in the area; 220,000 of whom live on the southern part of Vancouver Island, British Columbia. This population is concentrated near Victoria. Approximately 40,000 people live along the northern edge of the Olympic peninsula of Washington with the densest population in the Port Angeles area. Economic activity of southern Vancouver island is based on government, tourism, and forest industries. On the Washington shore, basic industries are forest products and tourism. On both sides of the Strait the water and its shoreline form an important recreational resource.

Water Traffic

Vessel activity in the Strait is shown on table 2.1-27. While precise data are not available, two-thirds of all traffic is estimated to be going to or from Canadian ports (ARCO 1978). Most tanker traffic, however, goes to Washington ports.

TABLE 2.1-27 VESSEL ACTIVITY, STRAIT OF JUAN DE FUCA, 1978

	Total	Ave/Day
All vessels 1/	18,154	49.8
Freighters	8,318	22.8
Tankers	1,343	3.7
Tugs	3,856	10.6
Ferries	2,034	5.6
Government	2,231	6.1
Miscellaneous 2/	400	1.1

Source: U.S. Coast Guard 1979

1/ Omits small boats other than tugs.
2/ Unclassified and identified nonreporting vessels.

Vessel activity in the Strait (west of Port Angeles) comprises a relatively small part of total traffic in the vicinity. East of Port Angeles, commercial vessels are required to participate in the Puget Sound Vessel Traffic System (VTS). On a typical day between June 1976 to May 1977, 536 vessels used the traffic system, including 404 ferries, 91 tugs, 21 freighters, and 4 tankers, with government and miscellaneous crafts comprising the remaining 16 vessels (ARCO 1978).

Fishing Activity

The number of small boats using the strait from Canadian ports is indicated by table 2.1-28.

TABLE 2.1-28 COMMERCIAL FISHING AND HOUSEHOLD PLEASURE BOAT OWNERSHIP, VANCOUVER ISLAND

Location	Commercial Fishing Boats (1976)	Households Owning One or More Pleasure Boats (1978)
Strait of Juan de Fuca area	0	N/A *
Victoria area	539	17,680
Duncan--Gulf Islands	144	4,147
Nanaimo area	458	N/A
	1,141 (boats)	21,827 (households)

Source: Fisheries and Environment Canada August 30, 1978.
* N/A Data not available.

The value of commercial fish and shellfish caught in Canadian waters off southern Vancouver Island in 1977 was $62.3 million. The herring catch amounted to $10.5 million (see table 2.1-29). Canadian recreational catch data are not available. The annual catch of fish and shellfish on the Washington side of the Strait is valued at $11.2 million. The catch for the whole of Puget Sound and the Strait combined is valued at $74.6 million. Table 2.1-30 shows fishery value estimates developed by the Washington Department of Fisheries as representative of present conditions.

TABLE 2.1-29 VALUE OF AVERAGE COMMERCIAL FISHERY CATCH, (1973-77) CANADIAN WATERS ADJACENT TO SOUTHERN VANCOUVER ISLAND (Thousands of Canadian Dollars, Prices Paid to Fishermen)

	Landed Value to Fishermen	Wholesale Value
Salmon	45,454	92,296
Shellfish	3,068	5,636
Shrimp	999	2,298
Clams	147	389
Abalone	57	74
Crabs	675	1,546
Oysters	1,190	1,329
Herring	10,456	31,369
Other fish	3,300	7,192
Total	62,278	136,493

Source: Fisheries and Environment Canada 1979

TABLE 2.1-30 PRESENT 1/ FISHERY VALUE, SELECTED INLAND WATERS OF WASHINGTON (Thousands of Dollars, 1976 Prices to Fishermen Except as Noted)

	Strait of Juan de Fuca2/	Hood Canal	Central Puget Sound	South Puget Sound	Puget Sound Total3/
Shellfish	1,264	3,003	4,177	5,798	21,917
Commercial bottomfish	260	263	17	140	1,187
Recreational bottomfish4/	51	511	281	10	976
Salmon production5/	1,958	8,833	5,545	4,163	35,380
Herring	--	--	224	146	1,600
Total	3,533	12,610	10,244	10,257	61,060
Salmon harvest	9,588	6,586	3,493	1,672	48,959

Source: Washington Department of Fisheries letter April 4, 1978
1/ Annual data for various years selected to represent typical values. Shellfish represent average production over 5-year period, 1972-1976. Bottomfish are 1976 data. Salmon production and harvest are based on 1975 commercial catch and 1976 recreational catch. Herring are 1976 catch (about one-half 1975 catch in South Sound and Hood Canal).
2/ Shellfish, includes area from Port Angeles to Port Townsend.
3/ Includes Strait of Juan de Fuca and Washington portions of Puget Sound.
4/ Valued at equivalent retail value of filleted fish.
5/ Excludes production in Puget Sound tribal and cooperative projects. Production represents value by spawning area rather than harvest area.

Native Americans

The Makah Reservation occupies 27,300 acres in the vicinity of Neah Bay and has a tribal population of 1,300. About 650 tribal members harvest an annual salmon catch valued at about $780,000. Some tribal members work in the logging industry (Lucas 1978). A $15 million fish hatchery is being constructed on the Sooes River (which empties into the Pacific Ocean) to enhance the tribe's fishery income (SRI International 1978).

The Lower Elwha Band occupies a reservation west of Port Angeles on the Lower Elwha River. Its population is about 500. Fishing represents a livelihood for 100 people; virtually every family includes a fisherman. Twenty-four tribal members work at the Band's fish hatchery, a $500,000 facility financed by the federal government. Another $500,000 is projected for expansion of Band fishery activity to include chum, coho, and steelhead species.

The Band is working to establish an economic base with its fishery operations, and through it preserve and strengthen its cultural integrity. This effort was bolstered recently by a U.S. court decision (United States vs. Washington, 384 F. Supp. 312, W.D. Wash 1974). This case, known as the Boldt decision, reserves for the Indians within the state an increased share of the annual commercial catch of anadromous fish. In the past the tribes had taken approximately 3-5 percent of the annual

Port Angeles and Clallam County

Population

The total population of Clallam County in 1977 was 41,100. This was an increase from 34,770 in 1970, an annual growth rate of 2.4 percent. Between April 1976 and April 1977 county population grew by 9 percent (SRI 1978), compared to 1.9 percent for the State of Washington between 1976 and 1977 (Office of Financial Management 1977). More than half of this increase came from an influx of retired people. The population over age 59 grew from 6,130 in 1970 to 7,730 in 1975; this was an increase of 26 percent compared to 6 percent for the total population (SRI 1978).

Port Angeles had a population of 16,890 in 1977. The city has also experienced an immigration of retired people and an outmigration of youth. Figure 2.1-14 presents the city's population trends by age group.

Other incorporated communities in Clallam County include Sequim, with a population of 2,555 and Forks, with 2,030 (in 1977).

Population Density

At present Port Angeles, with 8.46 square miles of land and an estimated population of 17,025 (1978), has a density of about 2,012 persons per square mile. Although this is relatively high, residential conditions in the town are not crowded. Most of the houses are single family dwellings built on lots large enough to permit yard space on all sides. Only 11 percent of residential dwellings in Port Angeles consisted of either multiple units or mobile homes (State of Washington Population Trends 1978).

The relatively high population density of Port Angeles is also is offset by the geographic setting of the town. The various hills and ravines on which the town is built provide scenic vistas for most homesites and create a number of smaller geographic communities. This natural setting tends to alleviate strains that high population density usually causes. In addition, Port Angeles is close to vast land areas free of residential habitation. Residents with access to transportation are within a few minutes of the harbor, Strait, national park, and forests.

Clallam County encompasses 1,753 square miles. About 1,040 square miles are under federal or state administrative responsibility. Another 174 square miles is privately owned forest land. The remaining 539 square miles is relatively densely settled, with about 77 persons per square mile, based on an estimated 1978 population figure of 44,240 (State of Washington Population Trends 1978). About 50 percent of these residents live in Port Angeles. Another 25 to 30 percent live in towns or settlements (e.g., Sequim, Forks, Clallam Bay, Sekiu, Dungeness, Sunland, etc.). Therefore, the population density outside of county cities, towns, villages and enclaves, is approximately 25 persons per square mile.

Income and Employment

Personal income for Clallam County totaled $231 million in 1975, or about $5,650 per capita. Table 2.1-31 shows the distribution of income by source.

POPULATION TRENDS BY AGE CATEGORY— Port Angeles

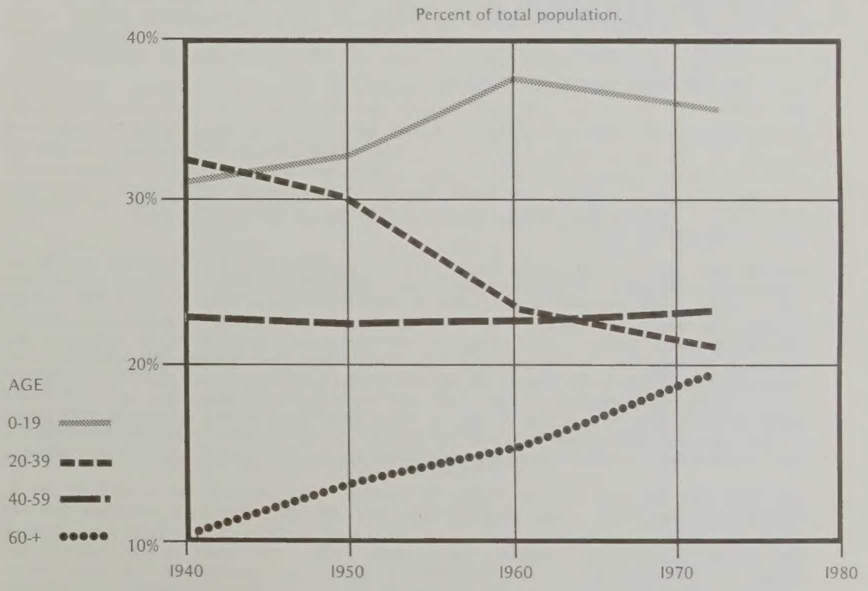


Figure 2.1-14

Source: Port Angeles Comprehensive Plan, 1976.

TABLE 2.1-31 PERSONAL INCOME, CLALLAM COUNTY, 1975
(Thousands of Dollars)

Income Source	Amount	Percent
Total personal income	$ 231,264	100.0
Net labor and proprietors income1/	141,604	61.2
Dividends, interest, and rent	45,928	19.9
Transfer payments2/	43,732	18.9
Total labor and proprietors income	149,680	100.
Wage and salary disbursements	125,562	83.9
Other labor income	6,591	4.4
Proprietors income	17,527	11.7
Farm	2,240	1.5
Nonfarm	15,287	10.2

Source: U.S. Department of Commerce, Bureau of Economic Analysis 1977

1/ Net labor and proprietors income differs from the total of such income by the subtraction of personal contributions for social insurance and an adjustment for income by place of residence rather than by place of work.

2/ Includes pensions, social security benefits, and other payments which do not represent current contributions to production.

County employment stood at 17,930 in 1978, while 1,910 were employed, or about 9.6 percent of the labor force (SRI International 1978). The economy depends heavily upon the forest products industry, which represents over 70 percent of manufacturing activity and includes the county's largest employers, ITT-Rayonier and Crown Zellerbach. Federal employment is also important. Table 2.1-32 shows the composition of employment in 1977.

Tourism and the proportionaly large retired population are regarded locally as significant components of the economic base. Although important, tourism's contribution to the total economy is difficult to measure. Hotel/motel receipts in Clallam County were almost $6 million in 1977 (Washington Department of Revenue, Quarterly Business Review 1978). According to the Washington Department of Commerce and Economic Development these receipts represent about 7.2 percent of total tourist expenditures, which would therefore amount to $83,3 million. Assuming these expenditures would occur mainly in the trade and service industries, they would generate about $77 million in personal income in the Puget Sound region (BEA area 154) based on the regional multiplier analysis of the Bureau of Economic Analysis (USDC 1977). Only a portion of this income would accrue to Clallam County residents, however.

Use data also indicate the importance of tourism. The Heart O'the Hills district of Olympic National Park (representing the Port Angeles vicinity) received 536,613 visits in 1978. In the same year ferry passenger traffic to and from Port Angeles was 536,663 (Black Ball Transport, pers. comm. 1979). The sport salmon catch in the Strait of Juan de Fuca in 1977 amounted to about 11.3 percent of the state total (134,674 versus 1.2 million). According to the Washington Department of Fisheries (pers. comm. 1979), the catch rate per trip on the coast is about three times that in other waters. The coastal catch was 63 percent of the state total. The catch in the Strait, when adjusted for the difference in rates, is estimated to account for 19.5 percent of the total trips (1.9 million), or about 366,000 trips. The 1977 bottom fish catch in the Strait was 69,158 fish.

The importance of the retired population to the local economy is unknown. It would appear that the contributions of both retirees and tourists would tend to make the trade and service sectors of the local economy larger than normal. Comparisons of these sectors for Clallam County and the state, however, do not show significant differences.

TABLE 2.1-32 COVERED EMPLOYMENT, CLALLAM COUNTY, 1977

Industry	Workers	Percent
Total	12,954	100.0
Manufacturing	4,249	32.8
Food and kindred products	59	0.5
Lumber and wood products	3,060	23.6
Printing and publishing	113	0.9
Other manufacturing	1,017	7.9
Nonmanufacturing	8,705	67.2
Agriculture, forestry and fishing	180	1.4
Mining	25	0.2
Construction	775	6.0
Transportation, communications, and utilities	731	5.6
Trade	2,985	23.0
Finance, insurance, and Real estate	515	4.0
Services	2,022	15.6
Government	1,472	11.4

Source: Washington Department of Employment Security, Employment and Payrolls, 4th Quarter 1977

Harbor Commerce

The harbor at Port Angeles determined the city's location. It primarily serves the forest products industries, but also is a refuge for ships in the Strait and a harbor for ferries, pilot boats, and sport and commercial fishing vessels. Table 2.1-33 shows the character of commerce to and from the harbor.

Table 2.1-33 WATERBORNE COMMERCE, PORT ANGELES, 1977
(Short Tons)

Code	Commodity	In	Out	Total
	Total	867,885	1,994,824	2,812,709 1/
2411	Logs (ship)	19,067	1,455,886	1,474,953
2412	Logs (rafted)	22,646	56,995	79,641
2416	Wood chips	340,228	67,862	408,090
2421+	Lumber, wood products	6,898	77,711	84,609
2611	Pulp	27,077	134,144	161,221
2621+	Paper products	19,112	117,953	137,065
2810	Chemical	214,713	179	214,892
2911+	Petroleum products	149,906	3,148	153,054
1442	Crushed rock, sand, gravel	27,426	4,488	31,914
	Other	40,812	26,458	67,270

Source: Corps of Engineers 1978 (Data adjusted to omit 119,073 tons crude petroleum foreign imports landed elsewhere.)

1/ Omits 351,230 tons intra-harbor movements.

Local Government Fiscal Capacity

The 1972 Census of Governments reported financial data for Clallam County and Port Angeles. Clallam County general revenue was $3,555,000 and (as a portion of this) tax revenue was $1,495,000. The total debt outstanding was $449,000. General expenditures were $3,409,000, of which the largest expenditures were for education, $709,000; and highways, $1,169,000.

Port Angeles general revenues were $1,893,000 and tax revenues, $825,000. General expenditures were $2,512,000 with $547,000 spent for highways, $298,000 for police protection, $184,000 for fire protection, $186,000 for sewage, and $210,000 for other sanitation. These payments included capital outlay totalling $559,000. In addition, utility revenues and expenditures were $2,275,000 and $2,407,000 (including capital outlay), respectively. Total debt outstanding in 1972 was $2,650,000, of which $236,000 was full faith and credit debt.

The total assessed valuation of the county was $713.8 million in 1977. Property tax levies amounted to $11.1 million with an average tax rate of 15.49 mills per dollar of valuation. The county imposes an 0.5 percent sales tax collected in addition to the state sales tax (Washington Department of Revenue 1978).

SOCIAL CONDITIONS

Population

Of the approximately 260,000 people that live along the Strait of Juan de Fuca, about 220,000 live on the southern part of Vancouver Island, British Columbia, with a heavy concentration near Victoria on the southeast tip of the island.

Approximately 40,000 people live along the northern edge of the Olympic Peninsula of Washington, with the highest population density occurring in the vicinity of Port Angeles, a city of about 17,000 population. (See 2.1 Economics for population discussion.)

Infrastructure

Housing

In addition to more than 17,000 year-round housing units, there are an estimated 1,000 units or rooms available for transient accommodations in the county (see tables 2.1-37 and 2.1-38). Results of a survey of hotels and motels in eastern Clallam County are listed in table 2.1-39 (Clallam County Governmental Conference 1977).

A comparison of the survey sample with the total county inventory shown in table 2.1-37 indicates that about 50 percent of all transient accommodations and approximately 75 percent of all transient rooms in the county were surveyed. The survey showed that average vacancy rates from June through September are approximately 2.1 percent. During the remaining 8 months the vacancy rate is about 50.4 percent. If these vacancy rates are applied to the estimate of the total number of transient accommodations in Clallam County, approximately 500 units would be vacant from October through May and only 21 units from June through September.

The survey reported that hotel and motel operators would be reluctant to house construction workers on a semi-permanent basis. Findings of the survey showed that only 183 rooms would be available from October through May; and only 47 rooms would be available from June through September.

TABLE 2.1-37 ESTIMATED CLALLAM COUNTY HOUSING FOR 1977

Area	Total Year-Round Dwelling Units	Occupied Units	Vacant Units	Vacancy Units
Clallam County	17,215	16,608	639	4.7%
Port Angeles	6,703	6,535	168	2.5%
Sequim	1,121	1,074	4	4.2%
Forks	765	739	2	3.4%
Unincorporated	8,658	8,260	398	4.6%

Source: Clallam County Governmental Conference 1977

TABLE 2.1-38 INVENTORY OF TRANSIENT ACCOMMODATIONS IN CLALLAM COUNTY FOR 1977

Type of Accommodation	Number of Accommodations	Number of Units with Toilet and Bathing Facilities
Hotel	3	72
Resort	14	146
Motel	33	799
Other	2	
Total	52	997

Source: NTPC 1978

TABLE 2.1-39 HOTEL AND MOTEL SURVEY RESULTS

Total Firms Surveyed	26
Total Number of Units Identified	754
Number of Units Currently Available for Semi-permanent or Permanent Occupancy	125
Number of Persons Occupying Semi-Permanent or Permanent Units	103
Number of Units Available for Temporary or Vacation-Type Transient Occupancy Only	629
Months Considered the "Off Season"	
Major Response	November through March
Range of Response	Late September to Late May
Average Occupancy During "Off Season"	
Range of Response (of those open)	20 to 100 percent
Average Occupied Rooms	374/754 = 49.6 percent
Months Considered the "Busy Season"	
Majority Response	June Through September
Range of Response	Early April to Mid October
Average Occupancy During "Busy Season"	
Range of Response	75 to 100 percent
Average Occupied Rooms	735/754 = 97.9 percent
Number of units proprietors would be willing to make available on a semi-permanent or permanent basis to house construction workers during construction of a local project	
During the "Off Season"	183 rooms
During the "Busy Season"	47 rooms (at full rates only)

Source: Clallam County Governmental Conference 1977.

Water Supply

The Elwha River provides Port Angeles with 13 to 14 million gallons of water per day. It is estimated that water supply would be adequate for 24,000 people (SRI International 1978). Port Angeles has a water supply of 65 million gallons of untreated water per day for industrial uses. All of that water is currently being used by wood processing mills in the city (SRI International 1978).

Ediz Hook is served from the treated water system by an 8-inch water line that reduces to 6 inches halfway out the hook. This line is sufficient for domestic uses only.

Sewage and Solid Waste Disposal

County wastewater treatment via sewerage systems and treatment facilities is limited to the Port Angeles area, Sequim, and Clallam Bay/ Sekiu.

The Port Angeles system has a peak load design of 10.1 million gallons per day, which can accommodate a population of 24,400. About 40 to 50 percent of the system's potential remains available for additional connections, but sewer lines would need to be laid (Clallam County Governmental Conference 1977). Federal law requires a secondary treatment system as of July 1, 1977. However, the Port Angeles plant probably will not be upgraded until 1980 or later, when grant monies are expected to become available to the city (SRI International 1978).

The Sequim area has a smaller sewerage system and treatment facility, which is designed for a peak load of 570,000 gallons per day. Maximum flows run to 500,000 gallons per day, while the average is 257,000 gallons per day ; leaving a remaining average capacity of over 350,000 gallons per day, but only 70,000 gallons per day remaining peak capacity. This system is in violation of federal laws as of July 1, 1978, for lack of secondary treatment.

The Clallam Bay/Sekiu area has two separate sewage treatment facilities. The Clallam Bay facility has an 80,000 gallons per day peak design load. Current data shows a maximum flow of 47,000 gallons per day and an average of 45,000 gallons per day with remaining capacities of 33,000 gallons per day and 35,000 gallons per day respectively. The Sekiu facility has a peak design load of 130,000 gallons per day. Current data shows a maximum flow of 20,000 gallons per day and an average flow of 10,000 gallons per day with remaining capacities of 110,000 gallons per day and 120,000 gallons per day respectively.

These two facilities have been in operation since September 1976. Reliable data will not be available until the systems have been in operation for at least 2 years. Both systems include secondary treatment and are in compliance with July 1, 1977, water quality requirements. Clallam County has two land fills to dispose of solid waste. The Port Angeles landfill, located at the western edge of the city, currently serves the eastern portion of Clallam County from Lake Crescent east to the Jefferson County line. Total capacity of the site is unknown; about 19 million tons of waste per year are disposed of. There appears to be no short run solid waste disposal capacity problem (Clallam County Governmental Conference 1977).

The Lake Creek landfill, located near Lake Creek and U.S. Highway 101, serves the area west of Lake Crescent to Jefferson County. Total capacity of the site is unknown as it is a function of the amount of gravel removed. About 6 million tons

TABLE 2.1-40 CHARACTERISTICS OF PUBLIC SCHOOL DISTRICTS SERVING EASTERN CLALLAM COUNTY

School District	School				Enrollment	Projected Enrollment			Statewide Average Professional Staff per 1,000 Pupils for Districts with Comparable Enrollments	District Expenditures per Pupil (dollars) 3/	Statewide Average Expenditures per Pupil for Districts with Comparable Enrollment (dollars)
	Type 1/	Grade	Number	Capacity	October 1977	1980	1982	Professional Staff per 1,000 Pupils 2/			
Clallam County											
Port Angeles (#121)	E	K-5	7	1,651	1,908	2,114	2,211	41.79	48.03	1,438	1,429
	J	6-8	3	1,276	1,032	1,050	1,150	52.81	51.34		
	S	9-12	1	1,587	1,706	1,508	1,412	49.56	49.96		
	P	NA 4/	1	NA	185	NA	NA	NA			
Crescent (#313)	E	K-6	1	110	140	152	160	74.72	69.94	1,563	1,858
	J/S	7-12	1	214	154	148	169	60.90	94.72		
Sequim (#323)	E	K-4	1	122 5/	574	600	630	47.36	47.71	1,230	1,413
	J	5-8	1	354 6/	531	604	614	43.21	45.77		
	S	9-12	1	760	669	637	660	47.52	53.36		
	P	NA	1	NA	106	NA	NA	NA			

Source: NTPC 1978; Clallam County Governmental Conference 1977.

1/E = elementary, J = junior high school or middle school, S = senior high school; P = private school.

2/Professional staff includes all certified school staff members such as teachers, administrators, guidance counselors, librarians, and so forth.

Figures in this column represent 1976 and 1977 school year values.

3/Statistics on per pupil expenditures are 1976 and 1977 school year (WSPI 1978).

4/NA = data not available.

5/Capacity will be 600 as of the 1979-1980 school year.

6/Capacity will be 620 in the 1980-1981 or 1981-1982 school years.

per year of waste are deposited. The possibility of converting this fill to a transfer site was suggested, with the solid waste being sited at the Port Angeles landfill. However, no confirmation of such a plan is available.

In addition to landfills, two transfer sites function as convenient collection locations in the county area. The Blue Mountain site serves the eastern end of the county. The Olympic Disposal Company is convenient to the northwestern portion of the county. Materials collected at these sites are sited in the Port Angeles and Lake Creek landfills respectively (Clallam County Governmental Conference 1977).

Schools

Eastern Clallam County is served by three public school districts: Port Angeles, Crescent, and Sequim (see table 2.1-40). See figure 2.1-22 for school district locations. Increasing enrollments are anticipated in 1980 and 1982, leading to continued overcrowding (NTPC 1978). However, enrollments in grades 9 to 12 are expected to decline, with sufficient capacity available by 1980 (NTPC 1978). See table 2.1-40.)

The shortage of classroom space in Crescent is expected to continue through 1982 if no new schools are built.

The Sequim district serves the easternmost portion of Clallam County. As shown in table 2.1-40, this district has a sizeable shortage of space in the elementary and middle schools. Expansion of the elementary school is due to be completed in August 1979. A similar expansion is planned for the middle school. Currently there is a surplus of about 100 classroom spaces in the senior high school that is expected to continue through 1982. One new school was scheduled to open in 1978 and two more are planned. The three new schools will increase Sequim school capacity by 30 percent.

Two private schools serve Port Angeles and Sequim. Peninsula Community College, a public 2-year college, is located in Port Angeles.

Medical Services

Three hospitals serve the area: Olympic Memorial Hospital in Port Angeles, Jefferson General Hospital in Port Townsend, and Forks Community Hospital in Forks. Table 2.1-41 describes these hospitals, their facilities, and service areas. Patients who require services beyond those offered at these hospitals are generally transferred to hospitals in Seattle or Bremerton. Emergency transportation in the district is provided by five ambulances.

No facility expansion is planned at any of the three hospitals. Occupancy rates in all three hospitals were low at the end of 1977. Existing hospital facilities for Clallam and Jefferson Counties appear to be more than adequate, given the existing availability of hospital beds (NTPC 1978).

Since July 1978 Olympic Memorial Hospital's emergency room has been staffed 24 hours per day, seven days per week. The hospital has a helicopter used twice weekly to transfer patients. The hospital staff does not perform complex neurosurgery, open heart surgery, or other major surgery (NTPC 1978).

Primary care physicians include general practitioners, family practice doctors, pediatricians, obstetricians/gynecologists, and general internists. The federal standard for adequate service is one primary care physician for every 2,000 residents served. Anything less than one primary care physician per 3,500 residents represents inadequate service. In 1977, Clallam County had one primary care physician for every 1,840 residents, representing an adequate level of service; and Jefferson County had one primary care physician for every 3,750 residents, representing an inadequate level of service (NTPC 1978). Locations of health care facilities are shown in figure 2.1-22 (Clallam County Governmental Conference 1977).

TABLE 2.1-41 CHARACTERISTICS OF HOSPITALS IN THE OLYMPIC HEALTH DISTRICT

Facilities and Service Characteistics	Olympic Memorial (Port Angeles)	Jefferson General (Port Townsend)	Forks Community (Forks)
Service Area	All Clallam County	Eastern Clallam and Jefferson Counties	Western Clallam and Jefferson Counties
Number of general care beds	86	31	30
Number of ICU/CCU[1] beds	8	2	2
Number of doctors on staff	30	9	6
Occupancy rate, 1977	72 percent	32 percent	14 percent
Patient days per year, 1977	22,715	4,927	1,533

Source: NTPC 1978

[1] ICU - intensive care unit; CCU - coronary care unit.

Police

Police protection for Clallam County is provided through three municipal departments, one county system, one state system, and one security guard system. Included in Table 2.1-42 are characteristics of the law enforcement agencies.

The port facility would be located within the jurisdiction of the Port Angeles Police Department. This department currently has 20 full-time officers and 14 reserves, with 6 patrol cars. The national average for full-time law enforcement officers in communities of 10,000 to 25,000 residents is 1.6 officers per thousand residents. Using 1978 population figures, Port Angeles currently has 1.16 full-time officers per thousand residents, below the national average (NTPC 1978).

TABLE 2.1-42 SUMMARY OF POLICE PROTECTION FOR CLALLAM COUNTY

Force	Patrolmen	Reserves	Patrol Cars	Detention Facilities Capacity	Average Occupancy
Sequim	5	9	2	Holding Room Only	In Port Angeles Data
Port Angeles	20	14	6	34 beds	20
Forks	6	3	3	7 beds	7+
Clallam County	17	19	15	Uses Port Angeles Facilities	In Port Angeles Data
Washington State Patrol	9	0	9	Uses Port Angeles Facilities	In Port Angeles Data

Sources: Clallam County Governmental Conference 1977; NTPC 1978

Fire

Fire protection to Clallam County residents is provided through five districts and three municipal departments see table 2.1-43.

The port facility would be within the service area of the Port Angeles Fire Department. The Washington Surveying and Rating Bureau has graded Port Angeles in protection class 5 on a scale of 1 to 10. Class 1 represents the highest relative level of fire defense, and Class 10 represents the lowest relative level of fire defense.

According to fire flow standards set by the Washington Surveying and Rating Bureau, the three pumpers and one combination ladder-pumper trucks presently in use provide the Department with sufficient of firefighting apparatus needed to respond to the largest likely fire (NTPC 1978). However, the number of available firefighters is slightly below the standard.

The proposed onshore storage facility is in Clallam County Fire Protection District 3. (See table 2.1-43.) A fifth station is presently being organized and was reported to have obtained a pumper truck and recruited volunteers (NTPC 1978). The Washington Surveying and Rating Bureau grades District 3 in protection classification 8, zones 2 through 4. The Green Point site is in zone 2, which means that although no hydrants are available the property is within 2 miles of the nearest fire station.

The required fire flow in Clallam County Fire Protection District 3 is about 3,000 gallons per minute. The district's equipment is sufficient to meet fire flow needs, although the location of the companies with respect to portions of the district exceeds the recommended travel distance.

Four other fire protection agencies are listed in table 2.1-43.

TABLE 2.1-43 FIRE PROTECTION SERVICES IN CLALLAM COUNTY

Fire Protection Agency	Number Full-Time Personnel	Number Volunteer Personnel	Number of Pieces Equipment	Rating */ (class)
Port Angeles	13	20	3 pumpers 1 ladder/pumper 1 rescue truck	5
Clallam County District 3	1	80	6 pumpers 3 tankers 2 aid vehicle	8 (Zones 2, 3, and 4)
Clallam County District 2				
Dry Creek	0	12	2 pumpers	8
Gales Addition	0	16	2 pumpers	(Zones 2, 3, and 4)
Clallam County District 4	0	6	2 pumpers	9
Sequim	0	20	1 pumper (belongs to Dist. 3) 1 equipment truck	(Zones 1 and 2) 6

Source: NTPC 1978

*/ Ratings provided by Washington Surveying and Rating Bureau.

Native Americans

Population and Infrastructure

Two Native American tribal groups occupy reservations on the northern coastal portion of the Olympic Peninsula. The Makah Tribe Reservation is 27,300 acres of the northwestern portion of Clallam county; the Lower Elwha Tribal community of the Clallam Indians have a 372-acre reservation approximately 12 miles west of Port Angeles.

The Lower Elwha Reservation was established on January 19, 1968. In 1978 the tribal roll contained the names of 250 individuals, 129 Native Americans living on the Reservation and an additional 394 living adjacent to it (Western Washington Agency, Bureau of Indian Affairs 1978).

No recent housing survey information is available. Domestic water is obtained from wells through a system installed and maintained by the U.S. Public Health Service. This agency also installed the reservation sewer system.

Children from the Reservation attend Port Angeles Public schools. Medical and hospital services are provided on a contract basis by Port Angeles physicians and hospital (Federal and State Indian Reservations, U.S. Department of Commerce 1976).

A Tribal Council, consisting of five elected members, governs the Lower Elwha Tribal Community. A manager is employed by the tribe to oversee business activities.

There were 1,005 Native Americans living on the Makah Indian Reservation in 1978; an additional 23 lived adjacent to it (Western Washington Agency, BIA 1978). The Makah Reservation, established in January 1855, was enlarged to its present size of about 27,300 acres in October 1873, and placed under Makah Tribal jurisdiction in 1934.

Neah Bay is the most intensively developed community on the Makah Reservation. According to a Tribal Planning Document, there were about 224 "non-government" residential dwellings in and adjacent to Neah Bay. Nearly 14 percent of these were mobile homes. There were 78 other residential structures in Neah Bay used for housing federal employees stationed in the community. The vacancy rate for all structures was 16 percent (Makah Reservation Community Plan 1972).

Prior to 1970 the water supply and sewer system in Neah Bay were deficient. Since that time new systems have been designed and installed. Makah children attend schools in the Cape Flattery District. Medical services are available at a clinic in Clallam Bay, at the hospital in Forks, or by contract in Port Angeles.

A tribal Council composed of five members governs the Makah tribe. An executive director, employed by the Makah, is responsible for implementing Tribal Council policies and programs (Federal and State Indian Reservations, Department of Commerce 1976).

Social Well-Being

This description consists of a discussion of selected indicators of social well-being in Port Angeles and Clallam County. Indicators of the social well-being of residents in the city and county include: population density and trends, employment opportunities and personal income, government services, and educational opportunities.

Population Densities and Trends

Population densities and trends are discussed in the preceeding Economics section. In terms of social well-being, residential conditions are not crowded.

Recent population growth has been uneven. Between 1970 and 1978, Port Angeles population increased at a rate of less than 1 percent per year; while Sequim increased by 10 percent per year. The overall Clallam county increase was a moderate 2.9 percent per year. About 80 percent of the growth in Clallam County between 1970 and 1978 was from migration. More than one-half the population increase has been retired persons. These disparities in growth rates and age distribution have not been sufficient to cause any apparent degradation of the social well-being of the area.

Employment Opportunities and Personal Income

In both Clallam County and Port Angeles employment opportunities, are restricted. For the past 5 years there has been a constant surplus of workers. 1977 is illustrative, with a year-round average unemployment rate of 10.5 percent.

Personal income on a per capita basis is slightly below the statewide average. Per capita income in Clallam County during 1975 was $5,650; for the state it was $6,284 (NTPC 1978).

City/County Government and Services

Port Angeles residents are governed by an elected city council and mayor. City business affairs are conducted by the city manager and staff personnel. County government is the responsibility of three elected County Commissioners. Personnel are located in both the County courthouse and in "detached" offices in Port Angeles. Additions to the courthouse are underway and when completed will serve to centralize County agencies.

There has been concern in the County over the need to develop updated comprehensive planning efforts. The Overall Economic Development Plan (OEDP) reflects this concern. It states, for example, that "lack of zoning in Clallam County, particularly industrial, continues to be a problem." The county has been updating or rewriting a comprehensive plan, "but progress has been slow."

Both county and city government have responded to the planning development efforts of NTPC proposal. The Port Angeles city council approved funds for a special referendum to determine resident views toward the oil port. The results, which showed 3,089 votes in opposition to the oil port and 1,673 favoring it, were taken by council members to indicate that the city should protest NTPC plans. Clallam County organized a "task force" to study the NTPC proposal, and the effect it might have on the county.

Educational Opportunities

Public education curricula and facilities permit Port Angeles youth to progress from kindergarten to a community college associate of arts degree without leaving the community. Three parochial schools exist in Port Angeles and Sequim along with five county public school districts.

County public school buildings and facilities are regarded as good to excellent. New school buildings and improvments have kept pace with enrollment and new curriculum directions. The teacher/student ratio in Port Angeles in 1974 was 1:18.5 (Clallam County Overall Economic Development Plan 1978).

Peninsula Community College, located on a 75-acre campus in the southeast portion of Port Angeles has a full-time enrollment of about 1,500 students. The college offers a full range of traditional academic courses plus a variety of vocational/career courses. In 1977 total enrollment approached 7,500 (OEDP 1978).

Quality of Life

Quality of life indicators are: lifestyle, recreational opportunites, aesthetics, and the area as a "place to live."

Life Style

Commuting to and from work for most employees in Clallam County and Port Angeles poses few problems. While there is some traffic congestion at the present time, "traffic jams" are unknown. Shoppers have easy access to parking, either in shopping center lots or on the street. Parking meters are not used.

Shopping is limited by the absence of large national and regional department stores since population numbers do not justify their presence. However, local merchants stock a wide variety of goods. National mail order stores exist in Port Angeles and Sequim.

County residents are provided with a broad range of professional-level services in the fields of health care, finance, insurance, and real estate.

People also have ample services available in the usual areas of need or interest (e.g. health, government, education, religion, news media, etc.). Residents appear to be well satisfied with life in Port Angeles and Clallam County.

Recreational Opportunities

Olympic National Park and Olympic National Forest are easily accessible. They offer a wide variety of recreational opportunities ranging from casual scenic drives on good roads, to extended camping, fishing, hiking, and outings for family groups.

The Port Angeles harbor and Strait also offer a wide range of recreational opportunities. State Highway 112, which provides access to beach sites west of Port Angeles poses some difficulties to county and city residents interested in going to the area. The highway is deteriorated (shoulders are narrow, non-existent, or badly damaged), narrow and in need of new safety signs and markers. Furthermore, State Highway 112 is used regularly by large log trucks.

Aesthetics

Port Angeles residents are concerned about improving the appearance of the downtown harbor area. Sequim at present has problems with the "highway sprawl" characteristic of towns undergoing rapid population growth. Waterfront areas in Clallam Bay, Sekio, and Neah Bay show signs of building deterioration.

Picturesque is a descriptive word commonly heard as county residents portray the countryside setting to an outsider.

Air and water quality is a relatively new concern. People are aware that shrimp, which had disappeared, can once again be caught in Port Angeles Harbor. The return of shrimp is widely credited to improved water quality. Port Angeles residents are also aware of and concerned about air quality, particularly in regard to particulates, since the downtown is considered a non-attainment area.

The City/County as a "Place to Live"

Clallam County and Port Angeles have certain readily evident and easily identified attractions, including a scenic setting, the picturesque nature of the region, recreational opportunities, and a small town atmosphere.

Native Americans

Social Well-Being and Quality of Life

Population density on the Lower Elwha Tribal Community Reservation is high. Some land adjacent to the Reservation is privately owned by tribal members. Others live in Port Angeles. Current data on age and sex distribution patterns are unavailable.

During 1978 there were 109 unemployed workers. The unemployment rate was 54 percent (Western Washington Agency, BIA 1978). Full-time employment for workers, to a large extent, is dependent on jobs in the Port Angeles wood products industry.

Tribal Council members are concerned about the welfare of their constituents. Council members actively support legal efforts to clarify tribal water rights. At issue is water in the Lower Elwha River from which 65 million gallons are pumped for industrial use. The Council contends this infringes upon treaty water rights.

Due to the overall size of the Makah Reservation, population density is relatively low. But, in Neah Bay community, where most of the Makah live, population density exceeds 400 persons per square mile.

The population of the Reservation has grown from about 700 (1970) to 1,028 (1978) (Western Washington Agency, BIA 1978). No data are available on age or sex distribution patterns.

In 1978 the unemployment rate was 62 percent (Western Washington Agency, BIA 1978). Most of the employment for tribal workers was in the categories of forestry, trade, and government (Makah Reservation Comprehensive Plan 1972). Fishing supplemented income for about 650 tribal members. Current data on personal income are not available.

During the early 1960s the Tribal Council initiated litigation to clarify fishing rights. Federal courts ruled in favor of the Makah claim to restrict non-tribal use of Makah fishing waters. The Tribal Council has organized a housing authority and Tribal Development Corportation.

Quality of life indicators for the members of the Lower Elwha Tribal Community and the Makah Tribe are lower than for non-Indian residents of Clallam County, because unemployment is higher and local employment opportunities appear more limited. Concerned efforts to improve the quality of life are underway.

Reservation population growth indicates that the Lower Elwha and Makah people prefer reservation life to life in a non-reservation atmosphere. Some of the factors contributing to the desirability of these reservations as "a place to live" are cultural identification, family and kinship, and a sense of "community."

SOCIAL AND ECONOMIC FACTORS IN PORT ANGELES

Bureau of Land Management

Northwest Air Photos, Port Orchard, Washington 1974

PIPELINE SYSTEM

CLIMATE

General Climate

The climate along the proposed pipeline route is as widely varied as the topography. Mountain ranges affecting climate are the Olympic, Cascade, and Rocky Mountains. The Olympics and Cascades capture much of the moisture carried from the Pacific by the prevailing westerly winds. They separate the mild, moist climate along the Pacific Coast from the drier, more continental climate farther inland. The Rocky Mountains form another major divide to the east with typical continental conditions.

The Port Angeles are is located in the "rain shadow" caused by the Olympic Range. Annual average precipitation is generally less than 25 inches, and is as low as 16 inches in the Sequim area. Winters are mild and summers are cool. Cloudiness is abundant.

The Puget Sound lowlands have a maritime climate with mild winters, relatively cool summers, and an abundance of cloudiness and rainfall. Most rainfall occurs from October through May. Mean annual precipitation varies from about 25 inches near Port Angeles to nearly 50 inches in the foothills of the Cascades.

In January average maximum temperatures range from 40° to 44° F, with average minimum temperatures between 32° and 34° F. In July, average maximum temperatures range from 72° to 76° F, while average minimum temperatures range from 50° to 52° F.

The Cascades experience colder temperatures than the Puget Sound lowlands. Precipitation is very heavy. The annual average near Snoqualmie Pass is about 96 inches. Much of the winter precipitation falls as snow, up to 400 inches annually at higher elevations. The summer season is relatively drier, with precipitation in the form of rainshowers or thunderstorms.

East of the Cascades, the annual average precipitation is between 10 and 20 inches; the moderating effect of the Pacific is not felt as much. Winters are colder and summers are substantially hotter. Average maximum temperatures in January are between 32° and 36° F, while average minimum temperatures are between 16° and 20° F. In July the average maximum temperature is between 85° and 90° F; the average minimum temperature is between 52° and 60° F.

Mountainous areas of northern Idaho experience moist conditions as prevailing westerlies lift up over the Rockies to produce more cloudiness and precipitation. Mean annual precipitation ranges between 20 and 40 inches depending on elevation. Most precipitation falls in the winter season, primarily in the form of snow. In the summer, rain is generally associated with thunderstorms. Temperatures vary greatly with elevation. In January average maximum temperatures range between 28° and 34° F, with average minimum temperatures from 10° to 20° F. Air drainage effects in mountain valleys can cause very low nighttime temperatures. In July average maximum temperatures range from 76° to 88° F, with average minimum temperatures ranging from 44° to 52° F.

Drier conditions prevail along most of the proposed pipeline route in western Montana, where annual average precipitation ranges from 12 to 20 inches. Average maximum temperatures in January range from 28° F to 34° F, and average minimum temperatures range from 8° F to 18° F. Mountain valleys can experience very cold conditions in the winter. Summer days are relatively warm with mean maximum in July ranging from 82° F to 88° F, while summer nights are cool with minimum from 44° F to 50° F. Cloudy conditions tend to persist in the winter, while sunny skies prevail in summer.

East of the Rocky Mountains the climate is dry and continental with very cold winters and hot summers. Average annual precipitation varies from less than 12 inches in parts of eastern Montana, to about 22 inches in northwestern Minnesota. Most precipitation occurs during spring and summer.

Coldest conditions occur in Minnesota. In January, average maximum temperatures range from 14° F in Minnesota to 36° F in parts of central Montana, while average minimum temperatures range from -6° F in Minnesota to 12° F in Montana. In July, average maximum temperatures range from 82° F in Minnesota to near 90° F in parts of eastern Montana; average minimum temperatures range from 48° to 58° F.

Severe weather rarely occurs along the western portion of the proposed pipeline corridor through Washington, Idaho, and western Montana. Thunderstorms are infrequent west of the Rocky Mountains, but occur with increasing frequency from central Montana eastward. Hailstorms follow a similar pattern. Hail is rare in Washington and northern Idaho. However, hailstorms are not uncommon in central and eastern Montana, North Dakota, and Minnesota. These storms can cause locally severe damage, primarily in late spring and early summer. Severe thunderstorms and tornadoes rarely occur in Washington, Idaho, or Montana. Tornadoes occur in North Dakota and Minnesota, primarily in late spring and early summer. In the winter, strong Chinook winds occasionally blow down the east slope of the Rocky Mountains in Montana. These winds are accompanied by unusually warm and dry conditions because of the strong downslope motion, and winter temperatures can rise from below 0° F to well above freezing in a few hours. The Chinook winds can cause flooding due to rapid snowmelt, especially in areas immediately downwind of the mountains.

Dispersion Potential

For a general definition of dispersion potential see section 2.1, Air Quality.

Dispersion conditions vary greatly and are strongly influenced by terrain. In mountainous areas, wind direction is influenced by orientation of canyons or mountain valleys. In relatively flat areas, prevailing winds tend to be southwesterly and somewhat stronger than in mountainous areas. In eastern Montana, North Dakota, and Minnesota the wind is free from terrain influence and tends to blow mainly from the west. Windy conditions often exist, especially in Montana. Morning mixing heights tend to be highest in the Puget Sound area and lowest over eastern Washington, eastern Montana, North Dakota, and Minnesota (Holzworth 1972). Afternoon mixing heights tend to be lowest in the Puget Sound area and highest in central Montana.

In general dispersion conditions are good along a large portion of the proposed pipeline corridor either because of strong winds or great mixing heights. It is more difficult to generalize for the mountainous areas, however. Dispersion conditions for the mountains of Washington, Idaho, and Montana tend to be the most restrictive as air flow and atmospheric mixing can be hindered by narrow mountain valleys or canyons.

AIR QUALITY

Air pollutant concentrations along the proposed corridor are generally low since the line would traverse mostly rural areas. Table 2.1-44 lists the observed ambient air quality levels for the year 1976 for various locations within about 50 miles of the route. Table 2.1-45 lists the applicable air quality standards.

Particulates are a problem mainly in urban areas. Windblown dust sometimes causes high particulate concentrations in rural areas. However, the EPA takes the position that high particulate concentrations caused by rural wind blown dust do not constitute an actual violation since little health hazard is involved. Levels are especially high in some parts of eastern Washington. Most of these high readings can be attributed to human activities, since samplers are seldom located in areas devoid of human activities that might cause fugitive dust. Particulates can be a problem in smaller cities as well as in large metropolitan areas.

Sulfur dioxide concentrations present a problem in some industrial areas. Air quality violations occur in Tacoma, Washington; the Silver Valley area in northern Idaho; and Helena, Montana.

High ozone readings are common in the Seattle area, primarily in summer. The nonattainment area for ozone covers all the Seattle-Tacoma metropolitan area and extends from Puget Sound eastward to the foothills of the Cascades near North Bend. In 1978, 1-hour average readings as high as 0.16 parts per million (ppm) occurred, which exceeds the federal standards of 0.12 ppm (Olympic Air Pollution Control Authority 1979). At one site, the state standard of 0.08 ppm was violated on 14 days that year.

NOISE

A general discussion of noise also may be found in section 2.1 Port and Onshore Storage Facilities: Noise.

Noise levels along the proposed pipeline corridor are generally low. Table 2.1-46 identifies significant noise sensitive receptors near the corridor. Most residential areas identified are located in western Washington and in North Dakota. These areas experience noise levels typical of small towns, with most noise sources originating from local traffic and highways, and light commercial activities.

No noise measurements have been made at the proposed terminus at Clearbrook. It is expected that noise levels at the proposed site are typical of a small town in a rural setting, with some noise from an existing crude oil storage facility.

Only two states--Washington and Minnesota--have established noise regulations. In Washington, noise from temporary construction activities between the hours of 7 a.m. and 10 p.m. is specifically exempted. Noise regulations promulgated by the state of Minnesota (Minnesota Pollution Control Agency 1974) limit medium noise levels in residential areas to 60 dBA during the daytime and 50 dBA during the nighttime.

TABLE 2.1-44 AMBIENT AIR QUALITY DATA MEASURED OVER THE PROPOSED NORTHERN TIER PIPELINE SYSTEM ROUTE

Micrograms Per Cubic Meter (ug/m^3)

Site No.	Location	Particulates		Sulfur Dioxide				Ozone	Nitrogen Dioxide	Carbon Monoxide (mg/m^3)	
		Annual Geo.Mean	Max. 24-Hr.	Annual Average	Max. 24-Hr.	Max. 3-Hr.	Max. 1-Hr.	Max. 1-Hr.	Annual Average	Max. 8-Hr.	Max. 1-Hr.
1	Port Angeles, Wash.[2]	67	252	26	78		572				
2	Sequim	37	68								
3	Port Townsend	31	68								
4	Anacortes	29	41								
5	Shelton	34	132								
6	Bremerton	45	111	0	105		472				
7	Seattle Metro. Area	83	314	26	158		1,076	120		26	34
[illegible]	Tacoma	87	337	26	499		3,386	60		14	22
9	Ellensburg	74	275								
10	Quincy	48	632								
11	Ephrata	46	141								
12	Moses Lake	77	173								
13	Lind	62	301								
14	Davenport	74	277								
15	Cheney	74	341								
16	Spokane Metro. Area	149	453	26	105		551	180		30	42
17	Coeur d'Alene, Idaho	77									
18	Silver Valley Area	108		249							
19	Frenchtown, Montana	35									
20	Missoula	86	386	71	210						
21	Helena	24	84	32	368	1,286					
22	Billings	64	200	160	998	1,601					
23	Glendive	27	166								
24	Williston	37	72								
26	Minot	71	204								
27	Devils Lake	59	159								
28	Bismarck-Mandan	86	397						26		
29	E. Grand Forks, Minn.	72	271								
30	Bemidji	30	190								

Source: Science Applications, Inc. 1978

1/For 1976

2/City Light Station, 1976

TABLE 2.1-45 AMBIENT AIR QUALITY STANDARDS APPLICABLE TO THE PROPOSED NORTHERN TIER PROJECT

Micrograms Per Cubic Meter (ug/m^3)

Pollutant	National		Wash. State	Olympic APCA	Puget Sound APCA	Idaho State		Montana State	North Dakota State	Minnesota State	
	Primary	Secondary				Primary	Secondary			Primary	Secondary
Sulfur Dioxide											
Annual average 1/	80		53	53	53	80		53	60	60	60
30-day average 1/					106						
24-hour average 2/	365		260	260	260	365		260 5/	260	260	260
3-hour average 2/		1,300					1,300			655	655
1-hour average 2/			1,048	1,048	1,048			1,048 6/			
1-hour average 3/			655	655	655				715		
5-minute average 4/					2,600						
Suspended Particulates											
Annual geometric avg. 1/	75	60	60		60	75	60	75	60	75	60
24-hour average 2/	260	150	150		150	260	150	200 7/	150	260	150
Carbon Monoxide 8/											
3-hour average 2/	10	10	10		10	10	10		10	10	10
1-hour average 2/	40	40	40		40	40	40		40	35	35
Photochemical Oxidants											
1-hour average 2/	240	240	160 9/		160	160	160		160	130	130
Hydrocarbons 10/ (Non-methane)											
3-hour average 2/, 11/	160	160	160 12/		160	160	160		160	160	160
Nitrogen Dioxide											
Annual average 1/									200 5/		
1-hour average 2/	100	100	100		100	100	100		100	100	100

1/ Never to be exceeded.

2/ Not to be exceeded more than once a year.

3/ Not to be exceeded more than twice in 7 days.

4/ Not to be exceeded more than once in 8 hours.

5/ Not to be exceeded over 1 percent of the days in any 3-month period.

6/ Not to be exceeded more than 1 hour in any 4 consecutive days.

7/ Not to be exceeded more than 1 percent of the time.

8/ Milligrams per cubic meter.

9/ 10 a.m. to 4 p.m., April 1 through October 31.

10/ This is not a standard; rather it is to be used as a guide in devising implementation plans to achieve the ozone standard.

11/ 6 a.m. to 9 a.m.

12/ 6 a.m. to 9 a.m., April 1 through October 1.

BLM

TABLE 2.1-46 SIGNIFICANT NOISE RECEPTORS ALONG PROPOSED PIPELINE ROUTE

State and County	Location	Type of Noise Sensitive Receptor	Approx. Distance in Feet Corridor Center to Nearest Noise Sensitive Receptor
Washington			
Island	Oak Harbor	Residences	500
Snohomish	Stanwood	Residential	500
	E. Stanwood	Residential	500
	Arlington	Residential	1,000
King	North Bend	Residential	500
Grant	South Ephrata	Recreational	500
Lincoln	Sprague	Residential	1,000
Idaho			
Benewah	Plummer	Residential	1,000
Shoshone	Kingston	Residential	500
	Murray	Residential	500
Montana			
Sanders	Paradise	Residential	2,500
Missoula	Frenchtown	Residential	4,000
Missoula	Missoula	Residential	500
Clark	Helena	Residential	500
Broadwater	Townsend	Residential	500
Meagher	Martinsdale	Residences	4,000
North Dakota			
Williams	Williston	Residential	500
	Epping	Residential	500
Mountrail	Ross	Residential	4,000
	Stanley	Residential	2,000
Ward	Berthold	Residential	500
McHenry	Towner	Residential	1,000
Pierce	Rugby	Residential	2,000
Benson	York	Residential	3,000
	Leads	Residential	100
Ramsey	Church's Ferry	Residential	1,000
Ramsey	Doyon	Residential	2,000
	Crary	Residential	500
Nelson	Lakota	Residential	1,000
Nelson	Michigan	Residential	1,000
	Petersburg	Residential	500
Grand Forks	Niagara	Residential	4,000
Grand Forks	Arvilla	Residential	2,000
Grand Forks	Grand Forks	Residential	2,000
	Emarado	Residential	4,000
Minnesota			
Polk	Crookston	Residential	5,000
Clearwater	Clearbrook	Residential	2,000

Topography

The proposed pipeline route would cross portions of six physiographic provinces--Pacific Border, Sierra-Cascade, Columbia Plateau, Northern Rocky Mountains, Great Plains, and Central Lowlands (Fenneman 1931). Each province is topographically distinct and is illustrated in the Map Addendum.

Pacific Border Province

From the onshore storage facilities (pipeline mile 0) to Snoqualmie (mile 122.9), the proposed pipeline would traverse portions of the Olympic Mountains and Puget Trough physiographic subprovinces. Between pipeline mile 0 and 11.6, the pipeline would be in the northern foothills of the Olympic Mountains, in a gently north sloping glacial outwash plain dissected by numerous slow to moderately flowing streams in shallow gullies, culminating at a near vertical 65 foot sea bluff near Port Williams. The remainder of the segment would be within the glaciated lowlands of the Puget Trough and would involve both marine and terrestrial portions.

Ocean depth measurements of the marine segments of Admiralty Inlet (pipeline mile 11.6 to 30) and Saratoga Passage (pipeline mile 42.7 to 50.5) indicate relatively smooth, morainal submarine topography with gentle slopes (less than 3 per cent) and water depths of up to 420 feet (NOAA 1977; Oceanographic Institute of Washington 1975; Shannon & Wilson 1979).

The land portion of this route is characterized by a low (35 feet) shoreline bluff at Partridge Point (pipeline mile 30) on the west shore of Whidbey Island; a very gentle slope at Polnell Point (pipeline mile 46) on the east shore of Whidbey Island; and moderately steep (56 degree) bluff about 80 feet high at Brown Point (pipeline mile 50) on the northwest shore of Camano Island.

Sierra-Cascade Province

From Snoqualmie (pipeline mile 122.9) to the Columbia River (pipeline mile 223.7), the route would be within the Cascade Range subprovince. It would cross through a natural break along the valleys of the South Fork Snoqualmie and Yakima Rivers. The area is characterized by rugged mountain peaks of similar elevation (generally 6,000 to 8,500 feet) with deep, steep-sided valleys, peri-glacial lakes, and numerous small, fast-flowing alpine streams. In the east, along the southern Wenatchee Mountains (a spur of the Cascade Range), are low rolling hills and parallel ridges, with numerous small drainages paralleling the ridges. See Map Addendum for illustrations of these and the following terrain features.

Columbia Plateau Province

From the Columbia River to Sprague, Washington (pipeline mile 332), the route would be within the "channeled scablands", a unique terrain consisting of a nearly featureless plain scoured by glacial meltwaters from the massive prehistoric Spokane flood and numerous smaller floods. These floods carved a series of steep-sided, nearly flatbottomed canyons (coulees) forming a netlike pattern of buttes and mesas in the otherwise sediment-covered basaltic plateau (Thornbury 1965). East of Sprague, the terrain merges into rolling hills and numerous lakes, underlain by thick deposits of windblown silt and sand.

Northern Rocky Mountain Province

From the Idaho-Washington border (pipeline mile 360) to the eastern boundary of Meagher County, Montana (pipeline mile 757), the pipeline route would be within a series of mountain ranges with indistinct boundaries and summits of similar elevation, generally separated by tertiary basins. The topography is quite steep (with slopes often in excess of 40 percent), and mountain peaks usually range between 5,000 feet in western Idaho and 8,000 feet in western Montana. Numerous fast-flowing, narrow-gorged streams open into broad flood plains in the tertiary basins.

Great Plains Province

From the eastern boundary of Meagher County, Montana (pipeline mile 757), to the Missouri escarpment, North Dakota (pipeline mile 1,236), the pipeline route would traverse a low, dissected plateau, generally with less than 300 feet of relief. It is characterized by a gently eastward sloping series of rolling, terrace-like hills, occasional highly dissected badlands, and generally northward and northeastward trending drainages that flow in wide meandering floodplains flanked by numerous terraces (e.g., the Missouri and Musselshell Rivers).

Central Lowlands Province

From the Missouri escarpment to the eastern terminus at Clearbrook, Minnesota, the pipeline route would lie within a low plain, characterized by thick accumulations of glacial debris. The surface is typically hummocky, with glacial moraines and a multitude of small drained and undrained basins. The plain of ancient glacial Lake Agassiz is near the border of North Dakota and Minnesota, between pipeline mile 1,380 and 1,450. It is a region of virtually flat terrain bisected by the Red River. (See Map Addendum.)

Geology

The proposed pipeline would be within a region exhibiting a wide range of geologic conditions, with deposits ranging in age from Precambrian to recent (see table 2.1-10). Past geologic conditions resulting in the formation of the present geologic deposits were sufficiently different along the proposed route to separate the area into two distinct geologic sections--the Cordilleran Mountain System (consisting of the Pacific Border, Sierra-Cascade, Columbia Plateau, and Northern Rocky Mountain physiographic provinces) and the Interior Lowlands (consisting of the Great Plains and Central Lowlands physiographic provinces). Each geologic province exhibits differences in geology, geologic structure, and tectonic history, as identified by King (1977). The geologic and tectonic maps (Map Addendum) of the proposed route illustrate these differences. As the physiographic provinces are widely recognized divisions, they are used to discuss the geologic conditions along the route.

Cordilleran Mountain System

Pacific Border Province. The proposed pipeline route would be within portions of two physiographic subprovinces--the Olympic Mountains, a structurally complex homoclinal mountainous uplift; and the Puget Trough, a north-south trending structural depression. Along the northern margin of the Olympic Mountains (pipeline mile 0 - 11.6, Map Addendum), the pipeline would be in areas of Tertiary volcanic rocks (basalts), and nonmarine sediments, locally overlain by a thin deposit of glacial drift (sand, gravel, silt, clay) less than 100 feet thick. Many of the streams draining the north flank of the Olympic Mountains contain thick sequences of unconsolidated Quaternary alluvium and glacial drift. Across the Puget Trough (pipeline mile 0 to mile 122.9), the pipeline would encounter largely Quaternary glacial and deltaic deposits, with some outcrops of Tertiary sedimentary and mesozoic volcanic rocks. Geologic information concerning the marine crossings is incomplete but it appears that Admiralty Inlet consists of glacially overridden glacial and interglacial deposits mantled by a variable thickness of recent marine sediments and Saratoga Passage contains relatively thick recent marine and deltaic sediments consisting largely of soft silt and clay (Shannon & Wilson 1979).

Sierra-Cascade Province. Most of the geologic material in this segment of the pipeline corridor consists of thick deposits of Quaternary alluvium and glacial debris of the South Fork Snoqualmie and Yakima River valleys. The Quaternary deposits are underlain by Tertiary crystalline rock (granite), some volcanic rock (basalt, andesite), and small areas of Mesozoic and Tertiary nonmarine sedimentary rocks; very little of this bedrock material is exposed.

Columbia Plateau Province. From the Columbia River (pipeline mile 223.7) to the Washington-Idaho border (pipeline mile 360), the pipeline route would be within a broad, gently down-warped, structural basin consisting of immense volumes of Tertiary basalt up to 10,000 feet thick. Much of it is overlain by Quaternary deposits of loess (wind deposited silt) and poorly sorted sand, gravel, silt, and clay of glacial origin.

Northern Rocky Mountain Province. From the Idaho-Washington Border (pipeline mile 360) to the Meagher County, Montana, line (pipeline mile 756), the pipeline route would lie within a complex geologic region, consisting largely of slightly metamorphosed sediments (slates, argillites) of Precambrian age, overlain by a variable sequence of unconsolidated Quaternary sediments and/or Mesozoic/Paleozoic sediments. In the mountainous regions, bedrock is at or near the surface. In the various stream drainages and along the flanks of the mountain ranges, relatively thick deposits of unconsolidated Quaternary sediments (alluvuim and glacial outwash) and occasional deposits of well-cemented Mesozoic/Paleozoic sediments would be encountered.

Interior Lowlands

Great Plains Province. From the Meagher County, Montana, line (pipeline mile 757) to the Missouri Escarpment, North Dakota, (pipeline mile 1236) the pipeline route would lie within a broad, mildly down-warped structural basin composed largely of soft, gently dipping upper Mesozoic (Cretaceous) and lower Tertiary (Paleocene) shales and sandstones, overlain in a number of locations by Quaternary alluvium and glacial debris. The shales and sandstones are generally exposed at or near the surface and in some areas contain large deposits of coal (Paleocene sandstone) and bentonite (Cretaceous shales).

Central Lowlands Province. From the Missouri Escarpment, North Dakota, (pipeline mile 1236) to Clearbrook, Minnesota (pipeline mile 1491), the pipeline route would lie within a broad, tectonically quiet, gentle arch. The terrain consists largely of glacial drift and lake deposits. The glacial drift is composed of accumulations of poorly sorted, unconsolidated clay, sand, gravel, and boulders up to 500 feet thick. It covers nearly all of the area, with the exception of the Red River

Valley, which exposes fairly well stratified clays and silts up to 120 feet thick deposited in ancient Lake Agassiz.

Geologic Hazards

Seven geologic hazards have been identified in the proposed pipeline corridor--seismicity (ground shaking, surface fault rupture, liquefaction), slope instability, outburst flooding, vulcanism, frost heaving, swelling clays and subsidence. However, only seismicity, slope instability and, to a lesser extent, outburst flooding, are considered serious threats along the proposed pipeline route.

Vulcanism, which would be limited to a few peaks in the Cascade Range (e.g., Mt. Rainier) has been eliminated as a serious hazard by its low frequency (approximately 2,000 to 10,000 years between major events) and limited extent (generally less than 10 miles from the summit of the volcano).

Swelling clays (bentonite), which would occur mainly in Upper Mesozoic (Cretaceous) sediments in eastern Montana; subsidence, which would be largely caused by mining; fluid withdrawal (e.g., water and/or petroleum); or compaction (soil and peat) and frost heaving, which would be most severe in eastern Montana, North Dakota, and Minnesota, should cause minimal damage to the project.

Seismicity

The proposed pipeline route would traverse several regions of varied seismic activity, as illustrated in the Map Addendum. As a consequence, three Seismic Risk Zones would be encountered, ranging from Zone 3 (high risk) to Zone 1 (low risk) as classified by the 1976 Uniform Building Code. The two highest risk zones (Puget Sound, Washington, and Helena, Montana) have the greatest frequency of strong earthquakes (4.8 or greater on the Richter scale), including six that registered 6 or greater (Von Hake and Coffman 1973). While several surface fault ruptures are known to occur along the proposed pipeline route, only those which have shown apparent movement within the past 2 to 3 million years are considered significant and will be discussed. Nineteen surface fault ruptures exhibiting known or suspected Quaternary movement have been identified within 10 miles of the proposed pipeline corridor--2 of them in Washington and 17 in Montana. Two of these faults--Prickly Pear and Scratch Gravel Hills (both located near Helena)--have shown features suggesting movement within the past 10,000 years and may be considered active. The remaining 17 faults have shown apparent movement during the past 2 to 3 million years (Pleistocene) but not in the past 10,000 years and are considered "potentially active". Other known or suspected active faults occur in the vicinity of the proposed pipeline, but their precise location have not been determined. In addition to the Quaternary surface fault ruptures, several geophysical anomalies (both magnetic and gravity) have been identified in the Puget Sound area; three of these features would be crossed by the pipeline. They have been tentatively identified as possible faults and, consequently represent potential geologic hazards. However, they may also represent structures that are nontectonic in nature (e.g., compaction of sediments resulting from glaciation or very thick accumulations of recent sediments). More detailed studies are required before to a definite conclusion is reached pertaining to their nature (Gower 1978). The Map Addendum depicts these known and possible faults.

Potential liquefaction problems that would be encountered by the pipeline are concentrated in areas of high seismic activity and saturated, nonclayey, poorly compacted soils. These potential problem areas are largely located in Washington and Montana, particuarly with alluvial valley and glacial plains in the Puget Trough, Cascade Range, and Northern Rocky Mountains as well as the marine portions across Admiralty Inlet and Saratoga Passage (see Map Addendum).

Slope Instability

Potential slope instability problems (landslides, mudslides, rock slides) that exist along the pipeline route occur in both coastal (Puget Trough) and upland (Cascade Range, Northern Rocky Mountains) environments, generally in areas of steep slopes (45 percent or greater), accompanied by heavy precipitation (15 inches or greater), strong wave action (coastal regions of the Pacific Trough), or repeated seismic disturbance upon loose rock material (e.g., talus), unconsolidated sediments (e.g., stream alluvium or glacial debris), or deeply weathered, fractured, or faulted bedrock. Very high landslide hazard is found in mountainous regions, particuarly on the steeper slopes, where severe climatic conditions and seismic activity have produced a number of unstable slopes. Local areas of potential landslide hazard occur along the entire route, particuarly near the larger drainages (e.g., Columbia, Missouri, Souris and Des Lacs Rivers) and along the coastal bluffs in Puget Sound, particularly Port Williams (pipeline mile 11.7), Partridge Point (pipeline mile 30), and Brown Point (pipeline mile 50.5). Maps in the Map Addendum illustrate these areas.

Outburst Flooding

An outburst flood is any overflow or inundation that comes from the catastrophic release of a dammed stream course. Potential causes of outburst floods are dam failures and temporary damming of streams by landslides, debris slides, snow and rock avalanches, or rapidly advancing glaciers.

Although outburst floods could occur along most of the proposed route, the areas with the greatest potential for outburst flooding are in the western portion, particularly in the rugged, steep terrain in the Cascade Range and Northern Rocky Mountains (see Map Addendum).

Mineral Resources

As the proposed pipeline would be within a 2-mile corridor and its exact position within the corridor has not yet been determined, the precise location in respect to active mines is not known. However, based on available information, the pipeline would cross a privately owned placer gold operation along Trail Creek (pipeline mile 432), a copper-silver lode mine along St. Louis Creek (pipeline mile 507), and possibly cross two gold placer operations along Nine Mile Creek (between pipeline mile 508 and 515). It would also cross, or come close to: (1) potential sources of aggregate (sand, gravel, and other mineral material) along the entire route; (2) silver claims near the Coeur d'Alene Mining district (Idaho); (3) gold placer claims in eastern Idaho and western Montana (pipeline mile 430 to 550); (4) and antimony claims along Prospect Creek (pipeline mile 450) near the active Babbit mine.

In addition to the previously mentioned mineral occurrences, the proposed pipeline would cross potentially strip-minable deposits of coal in the Circle and Williston-Avoca Known Recoverable Coal Resource Areas, located in the Weldon-Timber Creek and Williston Coal Fields, which contain some 500 million short tons of lignite coal (Mowat, pers. comm. 1979). There are no current applications for coal leases in these areas, but there are several industry nominations and the pipeline would cross some of them. The pipeline would also come within 2 miles of Burlington Northern's Circle West Project, a proposed strip mine and a processing plant for either liquid ammonia fertilizer or liquid methanol fuel (see Map Addendum.)

SOILS

Soils are formed by the interaction of soil parent material, climate, topography, plants, and animals. The proposed pipeline route traverses more than 200 soil series. Wide variations in soil parent material, climate, and topography account for the many different series.

Soil Classification

The Department of Agriculture Soil Conservation Service (SCS), classifies soils according to uniform procedures of the National Cooperative Soil Survey. The soil classification categories are orders, suborders, great groups, subgroups, families, and series. The last is the basic category dealt with in this discussion. Series of similar characteristics are commonly grouped into series associations in order to impart a more general knowledge of soils in a given area. Characteristics of the various soil series identified along the route were obtained from published soil survey reports, generalized soils maps, and other material from SCS sources and other government agencies.

Detailed soil surveys and soil association maps are available on about 60 percent of the route. Soils information on the remaining part of the route is meager and is available only in the form of old reconnaissance surveys or generalized statewide soil maps. Adequate information is lacking in all or parts of Kittitas County, Washington; Shoshone County, Idaho; Sanders, Missoula, Powell, Jefferson, Meagher, Golden Valley, Petroleum, Musselshell, Garfield, McCone, Richland, and Roosevelt Counties in Montana.

Soil Pattern Maps and Table of Soil Characteristics

Alignment sheets in the Map Addendum depict soil mapping units that have been identified along the proposed route. Characteristics of soil series and associations that are pertinent to pipeline construction and the associated potential impacts are given in the key to soil associations (following the alignment sheets). These characteristics include drainage, slope, soil depth, depth to water tables, textures, permeability, shrink-swell potential, corrosivity to steel and concrete, erosion potential, and influence of topsoil on revegetation. Some ratings and terms in these tables are not standard and are used solely for purposes of clarification within this document.

Alignment sheets and the table of soil characteristics are used in lieu of lengthy, detailed site-specific discussions of soils along the route.

Summary of Soil Characteristics

Agricultural quality of soils along the route varies considerably. About 11,300 acres within the proposed pipeline right-of-way have fair to good productive potential, based on soil properties as shown in table 2.1-47.

TABLE 2.1-47 SOIL PROPERTIES AS RELATED TO POTENTIAL PRODUCTIVITY

	Productivity Rating[1/]		
Soil Property	Good	Fair	Poor
Texture	Loam, silt Loam, fine Sandy loam	Silty clay loam, Sandy clay loam, Clay loam, sandy loam	Clay, loamy sand, sand
Gravel and cobbles (percent)	Gravel, less than 15	Gravel, 15-50; cobbles, less than 15	Gravel, more than 50; cobbles, more than 15
Salinity (conductivity of saturation extract) (mmhos/cm)	Less than 2	2-4	More than 4
Reaction (pH)	6.1-7.8	5.1-6.0; 7.9-8.5	Less than 5.0; More than 8.5
Inherent fertility	Very high, high	Moderate	Low, very low
Thickness of topsoil (inches)	More than 40	20-40	Less than 20
Topography (percent slope)	Less than 2	2-15	More than 15
Drainage	Good	Somewhat excessive moderately good	Excessive, somewhat poor, poor, very poor

Sources: U.S. Department of Agriculture SCS 1971 and 1951

1/ Soil productivity is the capacity of a soil for producing a specified plant or sequence of plants under a physically defined set of management practices. The ratings above assume equal management practices and should be used only for purposes of clarification of terms in this document.

Soil depth to bedrock or other parent material varies from a few inches in mountainous areas to 30 or more feet in the wind-laid silts of the Columbia Plateau.

Eleven of 12 major soil textures (USDA soil texture classification system) occur along the route. Silt loams and sandy loams are most common. Fine-textured soils consisting of clay loams, silty clay loams, and sandy clay loams are the second most extensive. Coarse textures are a small minority.

Soil Permeability. Water erosion potential is greatly influenced by steepness of slope. Approximately 11,500 acres would be susceptible to some degree of erosion because of loss of vegetative cover; about 4,350 acres would be highly susceptible because of strongly sloping to very steep slopes. About 4,500 acres would be highly susceptible to wind erosion.

Soil drainage varies from well drained to very poorly drained. Seasonal water tables within a few feet of the surface are common between Green Point and pipeline mile 131 and also from pipeline mile 1,140 in North Dakota to the Clearbrook terminal facilities. These are seasonal water tables that fluctuate considerably during the year. Small areas of organic soils such as peat and muck are closely associated with the high water tables and are confined to a few narrow drainage channels and depressions. About 750 miles of the proposed route contain soils that are highly corrosive to steel and about 50 miles are highly corrosive to concrete.

Soils with high shrink-swell potential can exert great lateral and vertical forces with moisture changes and can damage underground structures if offsetting design features are not employed. About 195 miles of the route would have soil series with high potential for shrinking and swelling.

The success of revegetation depends upon the quality of topsoil. Fair to good quality topsoil (see table 2.1-47) occurs on 62 percent of the land area within the proposed right-of-way corridor. The remaining 38 percent is poor or unsuitable for optimum revegetation. Some topsoils are judged to be poor because of wetness. Should these soils occur on lands being artificially drained, the poor rating would not apply. Some seasonally wet soils might be dry long enough for normal revegetation.

Other soils are extremely difficult to revegetate following surface disturbance because of high clay content and slow permeability. Still others are very shallow and when excavated could leave undesirable materials on the surface. These factors, along with low annual precipitation, are not conducive to survival of young seedlings. Site specific areas of soils such as these are shown on alignment sheets and described in the accompanying key to soil associations in the Map Addendum.

Physiographic Regions

The Map Addendum depicts physiographic regions traversed by the proposed route. Soils exhibit great differences from one physiographic region to another. Certain characteristics common in one region are uncommon in another. For this reason, physiographic regions are used to group soils for discussion purposes. Six major regions are associated with the route: 1) Pacific Border, 2) Cascade Range, 3) Columbia Plateau, 4) Northern Rocky Mountains, 5) Great Plains, and 6) Central Lowlands.

The following discussion describes the general nature of soils occurring in each physiographic region. While this discussion is somewhat more specific than the preceeding general summary, a more complete evaluation can be gained from the Map Addendum and the accompanying key to soil associations in the proposed corridor.

Pacific Border

This physiographic region, as it is crossed by the proposed route, consists of the Olympic Mountains and Puget Lowlands subregions. The former extends from the beginning of the route approximately to pipeline mile 11.6. Soils are moderately deep to shallow loams, gravelly loams, and silty clay loams with fine-grained alluvial deposits throughout. Steep slopes are only of minor occurrence. Water erosion potential is moderate and shrink-swell potential is low. Corrosivity to steel is medium to high. High water tables to within 12 inches of the surface are common on nearly level to gently sloping lands. Many soils have high compressibility and low structural bearing capacity. Topsoil suitability for revegetation is generally poor.

The Puget Lowlands subregion extends approximately from pipeline mile 11.6 to 122.9. Soils are highly permeable, gravelly, and stony loams formed in alluvium. Perched groundwater tables 2 to 3 feet below ground surface occur on 42 percent of the land route. Slopes are nearly level to moderately sloping and occasionally steep. Surface textures are mostly gravelly silt loams and sandy loams. Depths to cobble and gravel are 2 to 5 feet. Permeabilities range from slow to moderately rapid. Shrink-swell potential is low. Steel corrosion potential is high to medium. Potential for wind erosion is low; water erosion potential is low to medium.

The abundance of surface gravel is detrimental to revegetation but helps to impede erosion. Chief limitations of the Puget Lowlands soils are cemented hardpans, gravelly and cobbly subsoils, poor drainage, and occasional small areas of peat and muck.

Cascade Range

This physiographic region, as it relates to the pipeline route, is entirely within the state of Washington, and extends from approximately pipeline mile 122.4 to 223.7. Glacial drift, colluvium, and alluvium overlie bedrock on much of the route. Thickness of the drift is unknown. Soils are mostly shallow, gravelly, stony, and medium textured on gentle to very steep slopes. As the 101 mile route segment traverses this mountainous area the corridor remains primarily in steep-sided valleys. Parts of the route such as that near the summit must traverse steep slopes that are highly susceptible to water erosion. Susceptible areas are shown in the Map Addendum.

Columbia Plateau

The Columbia Plateau physiographic region extends from approximately pipeline mile 223.7 at the Columbia River in Washington to mile 360 in the western panhandle of Idaho. Three subregions have distinctly differing soil characteristics. These are Quincy Basin, Channeled Scablands, and Palouse Hills.

Quincy Basin is the western segment extending a distance of about 48 miles, mostly in Grant County. Soils are formed in glacial outwash materials and are level to very steep, medium- and coarse-textured, overlying gravel and basalt at depths ranging from 1 to several feet. Wind erosion potential is high. Susceptibility to water erosion is medium. Suitability of topsoil for revegetation is fair. Important soil series are Bakeoven, Lickskillet, Zen, Mabton, Ephrata, and Starbuck.

The remaining route across the Columbia Plateau alternates between soils of Channeled Scablands and Palouse Hills. Soils of Channeled Scablands occur on broad basaltic outwash plains of undulating relief dissected by many channels, lakes, potholes, and poorly drained depressions (Soil Survey, Spokane County, Washington 1968). These medium-textured soils are very shallow to moderately deep. Dominant series are Hesseltine, Cheney, and Uhlig.

Soils of the Palouse Hills occur on rolling loessial upland. They are deep, well drained and usually of silt loam texture and are highly susceptible to wind, rill, sheet, and gully erosion. Excessive wetting of these soils, as by irrigation, can collapse the natural structure and cause subsidence (NTPC 1978). Typical series are Ritzville, Willis, Athena, Naff, Larkin, and Freeman.

Northern Rocky Mountains

This physiographic region extends approximately from pipeline mile 360 in Idaho to pipeline mile 756 in Montana. Soils of this segment are confined to mountainous terrain consisting of narrow canyons, ridge tops, steep-sided slopes, and fossil flood plains. These are well-drained soils for the most part. Gentle to steep slopes make them moderately to highly susceptible to water erosion. Predominantly medium textured, they are very shallow to moderately deep and overlie quartzite, argillite, and dolomite. Cobblestones commonly occur on the surface through the soil to the parent material. Shrink-swell potential is generally low. The steel corrosion hazard is high only in wet bottomland locations. Topsoil suitability for revegetation is fair to good.

Great Plains

The Great Plains physiographic region extends from about pipeline mile 756 in Montana to about mile 1,236 in North Dakota. These soils are developed from glacial till, sandstone, siltstone, claystone, and shale on relatively smooth, rolling, terrace like plains sloping gradually eastward. Textures are mostly silt loams, sandy loams, clay loams, and silty clay loams. Slopes range from undulating to hilly and are susceptible from moderate to severe erosion from wind and water. Permeabilities, for the most part, are slow and moderate. Most soils are highly corrosive to steel. Topsoils are generally not conducive to quick revegetation. Soils known locally as "gumbo" occur in the badlands of the Missouri Breaks. They are extremely difficult to revegetate and difficult to negotiate by vehicle when wet. The proposed route crosses soils of this type in Garfield and McCone Counties of Montana. Soils high in bentonite content are traversed in eastern Montana.

Central Lowlands

The portion of the pipeline east of pipeline mile 1,236 is within the Central Lowlands physiographic region. Three subregions are traversed, Drift Prairie, Red River Valley, and Pitted Outwash Plains.

Soils of the Drift Prairie subregion are deep, poorly to well drained, and have medium and coarse textures. Slopes are nearly level to gently sloping. Water tables are generally below 5 feet.

A few soils in the lower portion of the landscape have seasonal water tables about 2 feet from the ground surface, from April to July and are susceptible to compaction when wet. In wet areas, scattered tracts of muck soils are present in many of the drainages and in large depressions ranging in size up to several hundred acres. Low to moderate shrink-swell potential presents no serious construction problems. These soils are highly corrosive to unprotected steel. Quality of topsoil is generally good for quick reestablishment of vegetation. Wind erosion potential is high and water erosion potential is medium.

The Red River Valley subregion extends from about pipeline mile 1,388 to approximately mile 1,451. Soils are deep, nearly level to undulating, and poorly drained. Water tables 1 to 2 feet from the surface are common from April to July. Soil compaction would be a problem if worked when wet. Surface textures are mostly loams and silt loams and are moderately permeable. Wind erosion potential is high and water erosion potential is medium. Shrink-swell potential is low to moderate.

These soils are highly corrosive to steel. Topsoil is generally of good quality for revegetation.

Soils of the Pitted Outwash Plains are poorly to very poorly drained. Extensive agricultural drainage systems have been installed in the more poorly drained soils. The soils are deep, nearly level to moderately sloping with surface textures of loamy fine sands, fine sandy loams, and clay loams. Permeabilities are moderate to rapid. Wind erosion potential is high; water erosion potential, low to medium. The steel corrosion potential is moderate to high, and the quality of topsoil is fair.

AQUATIC RESOURCES

Physical Components

The hydrologic resources along the proposed pipeline route will be discussed in terms of four major basins:

1. Puget Sound Basin (pipeline mile 0 to 145)
2. Columbia River Basin (pipeline mile 145 to 640)
3. Missouri River Basin (pipeline mile 640 to 1,180)
4. Souris-Red River Basins (pipeline mile 1,180 to 1,491)

Each section will be discussed in terms of surface water hydrology and ground water. Surface water discussion addresses physical and chemical characteristics of major streams crossed by the proposed pipeline. Major streams are those requiring U.S. Army Corps of Engineers Section 10 permits, those requiring individual or general Section 404 permits under the discretionary authority of the Corps, and those with a 100-foot or greater high water width. Major proposed stream crossings are identified by pipeline mile. Ground water discussion addresses water quality, aquifer types, location, and recharge characteristics.

Puget Sound Basin--Surface Water

The proposed pipeline route crosses the Puget Sound Basin from the onshore storage facility (pipeline mile 0) to the crest of the Cascade Mountains (pipeline mile 145) in western Washington. The 11 proposed major stream crossings in the basin are listed in table 2.1-48 and shown in the Map Addendum.

Characteristics for selected streams in Puget Sound basin are summarized in table 2.1-49. Width, depth, velocity, gradient, scour depth, and streambed composition are based on field inspections of the proposed stream crossings in spring of 1978. An additional survey will be conducted during spring, 1979 to provide data for Corps of Engineers permits required for stream crossings along the cross sound alignment. Low flow and 100-year flow flood plain widths are based on U.S. Geological Survey (USGS) gauging stations at or near the proposed crossings and/or by county flood-hazard maps.

TABLE 2.1-48 MAJOR STREAM CROSSINGS-PUGET SOUND BASIN

County	Stream	Pipeline Mile
Clallam	Dungeness	7
Snohomish	Davis Slough *1/	55
Snohomish	West Pass *1/	55
Snohomish	Pilchuck Creek	64
Snohomish	N Fk Stillaguamish	69
Snohomish	S Fk Stillaguamish	70
Snohomish	Pilchuck River	86
Snohomish	Skykomish	97
King	Tolt	111
King	Snoqualmie	123
King	S Fk Snoqualmie	134

1/*Salt water crossings near the northeast tip of Camano Island.

TABLE 2.1-49 CHARACTERISTICS OF SELECTED STREAM CROSSINGS

Stream Crossing Name	Pipeline Mile	Survey Date	Width (feet)	Depth (feet)	Velocity (ft/sec)	Gradient (ft/100ft)	Scour Depth (feet)	100 Year Flow		Low Flow		Stream Bed Composition
								Max.Width (feet)	Expected Occurrence	Max.Width (feet)	Expected Occurrence	
Dungeness	7	Information not received as of April 16, 1979										
Davis Slough	55											
West Pass	55											
Pilchuck Creek	64											
N. Fk.Stillaguamish	69											
S. Fk.Stillaguamish	70											
Pilchuck River	86											
Skykomish	97											
Tolt	111											
Snoqualmie	123											
S. Fork Snoqualmie	134	4/78	120	5	3	1-2	6-10	*240-650	Dec-Feb	20	Aug-Sept	Gravel, cobbles

Source: Adapted from stream crossing reports prepared for NTPC.
*Maximum width varies from 240 feet at the east edge of the proposed crossing to 650 feet on the west edge.
1/Table includes the streams in the Puget Sound Basin requiring special individual or group Section 404 permits under the discretionary authority of the U.S. Army Corps of Engineers or requiring Section 10 permits.

Variation of discharge for gauging stations near proposed major stream crossings are presented in table 2.1-50. Instantaneous minimum and maximum discharges recorded in cubic feet per second for the period of record and for the 1976 water year (October 1, 1975 through September 30, 1976) are listed if data are available. The most current year of record is used for stations that were discontinued before the 1976 water year. Mean monthly discharges for April through November, the proposed pipeline construction period, are based on 1976 or most current year of record. All discharge measurements are taken from USGS published records, except as noted. Seven-day and 30-day low flows with a 10-year recurrence interval are included when data are available (Pacific Northwest River Basins Commission App. 3, Tab. 30, 1970).

Dungeness River (pipeline mile 7)

The Dungeness River is a glacial fed river flowing north from the Olympic Mountains to the Strait of Juan de Fuca. It would be crossed in an urban area approximately 3.5 miles from its mouth. Natural discharge characteristics in this reach are modified by irrigation water, and municipal water withdrawal upstream of the proposed crossing. Potential sediments from construction activities would consist of fine sandy loams, silt loams, and silty clay loams. Discharge and water quality data are included in tables 2.1-50 and 2.1-51, respectively.

Pilchuck Creek (pipeline mile 64), North Fork Stillaguamish
(pipeline mile 69), South Fork Stillaguamish (pipeline mile 70).

Pilchuck Creek, North Fork Stillaguamish River, and South Fork Stillaguamish River would be crossed by the proposed alignment in the Stillaguamish Basin. Streams within the basin typically exhibit seasonal variation of stream flow. Maximum flows are anticipated in April from warming temperatures melting the snow pack coupled with spring rains. During August, the low-flow period, flows are sustained by groundwater. Stream discharges within the basin are not modified by dams regulating flow or by major municipal or industrial use.

South flowing Pilchuck Creek would be crossed 5 miles upstream of its confluence with the Stillaguamish River. The North Fork Stillaguamish meanders westerly, flowing through a broad glacial valley. The South Fork Stillaguamish also slowly meanders over a broad floodplain and would be crossed about 24 miles upstream of Puget Sound. Floodplains within the basin typically consist of sand, silt, clay, and peat with minor amounts of gravel. Discharge and water quality data for streams within the Stillaguamish Basin are included in tables 2.1-50 and 2.1-51.

Pilchuck River (pipeline mile 86), Skykomish River (pipeline mile 97),
Tolt River (pipeline mile 111), Snoqualmie River (pipeline mile 123).

The Pilchuck, Skykomish, Tolt, and Snoqualmie Rivers would be crossed in the Snohomish Basin which drains to Puget Sound. Typically two high flow periods occur within the the basin, one during late fall and winter caused by heavy precipitation, and the second during the spring from melting snow. Discharge characteristics of these streams are included in table 2.1-50.

The south flowing Pilchuck River would be crossed within about 7 miles of its confluence with the Snohomish River. Some of the river discharge is diverted upstream of the proposed crossing for municipal use by the town of Snohomish. No dams are present in the Pilchuck River basin regulating or modifying natural flow

TABLE 2.1-50 ESTIMATED WATERSHED DISCHARGE DATA--PUGET SOUND BASIN[1]

Stream Crossing Name	Station No	Period Of Record	Extremes [2]					Means [2]									Average [2] Discharge Period of Record	Low Flow [2] (10 year reoccurrence)	
			Pd. of Record		Most CY Data														
			Min.	Max.	Min.	Max.	Year	Year	April	May	June	July	Aug.	Sept.	Oct.	Nov.		7-Day	30-Day
Dungeness	12048000	1937-1976	68	6,820	139	5,150	1976	1976	297	627	589	593	337	200	442	727	394	95	109
Pilchuck Cr.	12168500	1952-1975	0.5	6,900	2.1	5,820	1975	1975	252	229	99.0	24.1	57.0	28.6	12.0	318	281		
North Fork Stillaguamish	12167000	1898-1932 1958-1976	9.7	61,000	425	51,800	1976	1976	2,651	4,311	3,614	2,832	1,757	1,014	2,482	4,894	2,623	200	240
South Fork Stillaguamish	12161000	1928-1976	55	32,400	114	8,700	1976	1976	1,096	1,786	1,340	980	649	422	1,734	2,470	1,086	130	163
Pilchuck River	12152500	1976				8,510												30	33
Skykomish	12134500	1928-1976	315	88,700	668	19,000	1976	1976	3,477	7,993	7,142	6,416	3,107	1,525	3,302	7,723	4,017	490	580
Tolt	12148500	1928-1932 1937-1976	53	17,400	146	3,400	1976	1976	593	632	461	339	274	193	519	1,255	610	64	75
Snoqualmie	12144500	1898-1926 1958-1976	9.7	61,000	425	51,800	1976	1976	2,651	4,311	3,614	2,832	1,757	1,014	2,482	4,894	2,623		
South Fork Snoqualmie	12143400	1960-1970	28	7,090	28	1,440	1970	1966	520	621	440	219	61.3	38.3	133	225	295	83	92

Source: U. S. Geological Survey and EPA STORET data.

[1] Table includes published discharge data for the larger streams in the Puget Sound Basin. No data were found for Davis Slough and West Pass, which are salt water crossings.

[2] Cubic feet per second.

Kayaking

TABLE 2.1-51 WATER QUALITY CHARACTERISTICS OF MAJOR STREAMS CROSSED-PUGET SOUND BASIN[1]

Stream Crossing		Period of Record or Date	State Classification	Temperature (°C)		pH		Dissolved Oxygen (mg/1)		Specific Conductance (umhos/cm)		Disolved Solids (mg/1)	
Name	Station Number			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dungeness	12048000 Near Sequim	1959-1970	A	8.7	2.4-16.1	7.6	6.3-8.0	11.4	9.7-13.5	112	117-152	65	54-78
Pilchuck Creek	12168500 Near Bryant	1952-1968 1969-1970	-	-	1.0-28.0	-	-	-	-	-	-	-	-
North Fork Stillaguamish	12167000 Near Arlington	1973-1974	A	-	3.1-14.7	-	6.3-7.9	-	9.9-15.1	-	35- 95	-	-
South Fork Stillaguamish	12161000 Near Granite Falls	1973-1974	AA	-	3.0-17.0	-	7.0-7.7	-	10.0-14.3	-	23- 54	-	-
Skykomish	12134500 Near Gold Bar	1969-1970	AA	8.8	2.6-18.3	-	6.5-7.5	11.6	9.6-13.9	32	20- 46	23	13-36
Tolt	12148500 Near Carnation	1960-1966	AA	10.6	3.7-23.2	-	6.6-7.5	11.1	8.7-14.7	43	24- 65	33	21-47
Snoqualmie	07D130 At Snoqualmie	1959-1978	AA	9.0	2.5-17.5	6.9	6.2-7.5	11.2	8.2-14.0	37	16- 61	25	14-38

Source: U.S. Geological Survey and Puget Sound Task Force-Pacific Northwest River Basins Commission 1970.

[1] Table includes published water quality data for larger streams in the Puget Sound Basin.
No data were found for Davis Slough, West Pass and the Pilchuck River.

characteristics. The Skykomish is also unregulated by dams, but flows generally westward. It would be crossed within 2 miles of its union with the Snohomish River near the town of Monroe, Washington.

The west flowing Tolt River's proposed crossing would be about 5 miles upstream of its confluence with the Snoqualmie River. A dam on the South Fork Tolt River about 10 miles upstream of the crossing regulates flow in the basin.

The Snoqualmie River flows northwest, and would be crossed just downstream of the confluence of the North Fork and Middle Fork Snoqualmie Rivers, north of the town of North Bend, Washington. No dams are present in the basin.

The river floodplains, potential sediment, in the Snohomish Basin consist of sands, gravelly sands, and sandy loams in the upper reaches becoming progressively finer textured to fine sandy loams, silt loams, clay loams, silty clay loams, and peats in the lower reaches (Pacific Northwest River Basin Commission (PNRBC) 1970). Water quality data for streams in the Snohomish Basin are included in table 2.1-51.

South Fork Snoqualmie River (pipeline mile 134)

The proposed crossing is located in a narrow, constricted portion of the river valley with steep to precipitous walls. The channel, which appears to be stable at its present level, is controlled by bedrock immediately upstream of the crossing location. A minor amount of aggradation (building up) may be occurring on the flood terraces. The north bank is composed of gravel and cobbles and is covered by a dense growth of small alders and thick brush. The south bank is composed of dense angular cobbles and gravel mixed with silty sand. Both banks appear to be stable. Detailed crossing characteristics and discharges are presented in tables 2.1-49 and 2.1-50, respectively.

Water quality has been classified AA, indicating high water quality suitable for all beneficial uses (table 2.1-51).

Puget Sound Basin--Groundwater

The Puget Sound Basin, pipeline mile 0 to 145, can be subdivided into three groundwater regions, the Puget Sound Lowlands, Whidbey and Camano Islands, and the Puget Sound Lowland-Cascade Range transition zone.

The most significant aquifers in the Puget Sound Lowlands are the alluvial and glaciofluvial deposits covering the valley floors and lowlands (PNRBC 1970). Water levels in the unconfined aquifers lie between 25 and 50 feet below the surface, with perched zones that have water levels of 10 feet or less (Molenaar and Noble 1970). Recharge is primarily from precipitation and secondarily from runoff. Discharge is through springs, both onshore and offshore. Water is used for domestic, agricultural, and livestock purposes.

Ground water on Whidbey and Camano Islands, pipeline mile 30 to 55, is generally found in glacial drift consisting of glacial till sands, gravels, and clays. Aquifers exist above and below sea level. Those above sea level may occur under artesian or water table conditions, but those below sea level, with rare exception, are artesian. These deeper aquifers are the most used because of their better yield characteristics (PNRBC 1970). Recharge to the aquifers generally ranging from 10 to 150 feet below the land surface is by infiltration of precipitation. Natural discharge of aquifers above sea level is through seeps and springs along the sea cliffs, and to a lesser degree along surface drainages (PNRBC 1970).

Water quality is fairly good with dissolved solids ranging from 100 to 300 milligrams per liter (mg/l), although higher values have been measured in some wells. Objectionable levels of iron have been reported in some shallow and deep wells. Abnormally high concentrations of chloride occur locally near Puget Sound, probably resulting from sea water encroachment (PNRBC 1970). Ground water is used for domestic and municipal supplies.

Groundwater in the Puget Sound Lowland-Cascade Range transition zone is generally encountered within 50 feet of the surface. Areas of shallow water that may be less than 10 feet below the surface exist in river and stream valleys (Luzier 1969).

Recharge to the unconfined aquifer is from rainfall and snowmelt in the transition zone. Discharge, particularly in the more mountainous region of the transition zone, is through springs which are the principal supply to streams during late summer (PNRBC 1970). Use of ground water from the unconfined zone is for domestic, irrigation, and livestock supply.

The groundwater is generally good quality, with constitutents well within Environmental Protection Agency drinking water limits. This water is of the calcium-magnesium bicarbonate type (Walters and Kimmel 1968). Most of the groundwater contains less than 200 parts per million (ppm) of dissolved solids although higher concentrations may occur near shore lines as a result of seawater encroachment (PNRBC 1970). The hardness of the water varies from soft, less than 60 mg/l to hard, over 200 mg/l. Iron concentrations may be high in localized areas within the basin. High sulfate concentrations are present in some of the Cascade Range aquifers.

Columbia River Basin--Surface Water

The proposed pipeline route crosses the Columbia River Basin from the crest of the Cascade Mountains (pipeline mile 145) to the Continental Divide (pipeline mile 640) in western Montana. Fifteen crossings of 10 major streams are proposed for the basin as shown in table 2.1-52 and in the Map Addendum.

Detailed stream crossing characteristics for selected streams in the Columbia River basin are summarized in table 2.1-53. Data are based on field investigations during the summer of 1978. Low flow and 100-year-flow channel widths and expected time of occurrence are interpreted from records of gauging stations near the proposed crossings.

Estimated stream discharge data are included in table 2.1-54. Instantaneous minimum and maximum discharges recorded in cubic feet per second for the period of record and for the 1976 water year are recorded, if available. The most current year of record is used for stations that were discontinued before the 1976 water year. Mean monthly discharges for April through November, the pipeline construction period, are based on 1976 or most current year of record. All discharge measurements are taken from USGS published records, except where noted.

TABLE 2.1-52 MAJOR STREAM CROSSINGS-COLUMBIA RIVER BASIN

State and County	Stream	Pipeline Mile
Washington		
Kittitas	Yakima	182
Kittitas/Grant	Columbia	224
Grant	Rocky Ford Creek	253
Grant	Crab Creek	259
Idaho		
Benewah	St. Joe	386
Shoshone	S. Fork Coeur d' Alene	414
Shoshone	Prichard Creek	435
Shoshone	Prichard Creek	441
Montana		
Sanders	Clark Fork	464
Sanders	Thompson	468
Sanders	Clark Fork	470
Sanders	Clark Fork	470
Sanders	Clark Fork	471
Sanders	Clark Fork	496
Missoula	Blackfoot	567

Yakima River (pipeline mile 182)

The Yakima River at the proposed crossing site is situated in a wide, moderately sloped valley. The channel appears to be laterally and vertically stable. Both banks are characterized by natural erosion protection consisting of scattered brush, seasonal grass, and a few large trees. There is no evidence of undercutting of the sand and gravel channel banks. Detailed river crossing characteristics and discharge data are summarized in tables 2.1-53 and 2.1-54.

The Washington State Department of Ecology (1977a) has classified this reach of the Yakima class A (see table 2.1-55).

Columbia River (pipeline mile 224)

The proposed Columbia River crossing spans from an ancient terrace on the west to an alluvial fan at the mouth of Lynch Coulee. The fan is underlain by sand, cobbles, and gravel. It is lined with dense brush and weeds and shows little sign of erosion. The west bank is sparsely vegetated with sagebrush and scattered grass. Wave action along the bank has eroded most of the fine-grained material from between boulders leaving an armor of rounded boulders. Detailed river crossing characteristics are presented in table 2.1-53.

The state of Washington has classified this reach of the Columbia River class A (table 2.1-55) indicating high quality water suitable for beneficial uses (Washington Department of Ecology 1977a).

Rocky Ford Creek (pipeline mile 253)

The proposed crossing of Rocky Ford Creek is 2 miles upstream of Moses Lake. The stream flows through flat scabland topography, is about 50 feet wide, and has a 2,000-foot-wide flood plain as determined by aerial photo interpretation. The surrounding soils are silty loam on shallow bedrock.

The Washington State Department of Ecology has not yet classified the stream's water quality. However water quality and discharge data are provided in tables 2.1-54 and 2.1-55, respectively.

Crab Creek (pipeline mile 259)

Crab Creek flows through large areas of the eastern Washington plateau before discharging into Moses Lake and Potholes Reservoir. The proposed crossing is 10 miles north of Moses Lake, Washington. Aerial photo review indicates a 300-foot-wide crossing in a 300-foot-wide floodplain. The topography appears to be scabland, with silty loam soils on shallow bedrock. Discharge data are shown in table 2.1-54.

The Washington State Department of Ecology has classified Crab Creek class B in water quality (table 2.1-55).

St. Joe River (pipeline mile 386)

The proposed St. Joe River crossing location is characterized by a main channel and a backwater channel separated by a densely vegetated lateral bar. A riprapped levee and highway embankment make up the south and north banks, respectively. Streamflow is controlled somewhat by Coeur d'Alene Lake located about 8 miles downstream of the proposed crossing. The channel is essentially stable in its present configuration. River crossing characteristics based on a July 1978 inspection of the proposed crossing are presented in table 2.1-53. Discharge data are included in table 2.1-54.

The state of Idaho has classified the St. Joe class A, indicating high quality water suitable for all beneficial and natural resource uses (table 2.1-55).

South Fork Coeur d'Alene River (pipeline mile 414)

The South Fork Coeur d'Alene River meanders over a one-fourth-mile wide, flat, west-trending valley in the vicinity of the proposed crossing. The west stream bank is a stable heavily riprapped railroad embankment. The stream is bordered on the east by a sand, gravel, and cobble gravel bar vegetated with scattered willows, grasses, and bushes. Detailed river crossing characteristics and estimated discharge data are included in tables 2.1-53 and 2.1-54, respectively.

Water quality of the South Fork Coeur d'Alene River is relatively poor as evidenced by data presented in table 2.1-55. The range of pH values are especially low due to acidic mine drainage.

TABLE 2.1-53 CHARACTERISTICS OF SELECTED STREAM CROSSINGS--COLUMBIA RIVER BASIN

Stream Crossing								100 Year Flow		Low Flow		
Name	Pipeline Mile	Survey Date	Width (feet)	Depth (feet)	Velocity (ft/sec)	Gradient (ft/100ft)	Scour Depth (feet)	Max.Width (feet)	Expected Occurrence	Max.Width (feet)	Expected Occurrence	Stream Bed Composition
Yakima	182	4/78	150 - 180	5	10 to 12	0.25 to 2	10	275	Jan-Mar	30 - 60	July-Sept	Cobbles, gravel
Columbia	224	4/78	2,600±	70±	1.5-2	--	4	2,600±	May-June	2,500±	September	Sand, gravel cobbles
St. Joe	386	7/78	400	5+	<1	.02	4-5	1,700	Dec-Feb	180	Aug-Oct	Sand
South Fork Coeur d'Alene	414	8/78	50	6	2	.02	3	200	Dec-Feb	20	Aug-Nov	Gravel, cobbles, sand
Clark Fork	464	7/78	650	22±	1	0.02	4-6	700	May-June	600	Aug-Feb	Gravel, cobbles, sand
Clark Fork	470	7/78	850	10-15	3	0.02	5-6	1,500	May-June	400	Aug-Feb	Sand, gravel
Clark Fork	470	7/78	550	5-7	3-4	0.02	2-4	600	May-June	150	Aug-Feb	Gravel, cobbles
Clark Fork	471	7/78	675	5	3-4	0.02	2-3	600	May-June	400	Aug-Feb	Sand, gravel
Clark Fork	496	8/78	400	7-9	2	.01	3	1,500	May-June	270	Aug-Feb	Gravel, cobble
Blackfoot	567	8/78	150	4	3-4	.2	4	350	May-June	80	Oct-Feb	Gravel, cobble

Source: Adapted from river crossing reports prepared for Northern Tier Pipeline Company.

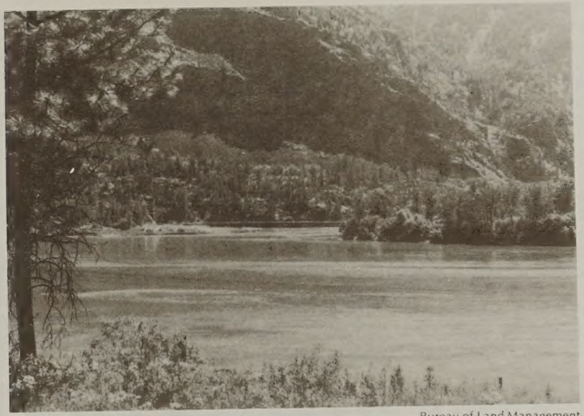
[1]/Table includes the streams in the Columbia River Basin requiring special individual or group permits under the discretionary authority of the U.S. Army Corps of Engineers, or requiring Section 10 permits.

TABLE 2.1-54 ESTIMATED WATERSHED DISCHARGE DATA--COLUMBIA RIVER BASIN

Stream Crossing		Period of Record	EXTREMES (cfs)					Means (cfs)									Average Discharge
Name	Station No		Pd.of Record		Most CY Data												Period of Record (cfs)
			Min.	Max.	Min.	Max.	Year	Year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	
Yakima	12479500	1906-1976	426	25,600	426	9,460	1976	1976	2,999	3,527	2,279	2,529	2,210	1,730	939	766	2052
Columbia	12462600	1930-1976	4,120	629,600	47,700	264,000	1976	1976	136800	193700	169500	190600	201800	122700	82970	102800	122,700
Rocky Ford Creek	12470500	1942-1976	20	212	66	110	1976	1976	76.6	83.9	92.1	96.6	99.9	97.3	104	94.3	79.8
Crab Creek	12467000	1942-1976	No Flow	10,400	25	800	1976	1976	119	63.4	59.3	77.3	92.4	90.7	92.9	57	N/A
St. Joe	12414500	1920-1976	91	53,000	386	21,600	1976	1976	5,449	11,526	5,022	1,734	827	530	580	1,186	
S.Fork Coeur d'Alene	12413300	1966-1974	50	11,500	92	11,500	1974	1974	438	852	331	186	116	161	104	292	457
Prichard Cr.	Near Murry, ID	1974-1977	2.9	193													37.1
Thompson	12389500	1956-1976	68	6,080	131	3,590	1976	1976	991	1,755	952	495	310	214	196	212	501
Clark Fork	12354500	1910-1976	1,000	68,900	3,110	55,000	1976	1976	14,460	38,410	26,940	11,520	5,402	4,319	5,896	6,038	7,629
Blackfoot	12340000	1899-1976	200	19,200	600	14,000	1976	1976	3,930	9,575	5,499	2,256	1,086	784	1,047	1,098	1,679

Source: U.S. Geological Survey and EPA* STORET data.

1/Table includes the larger streams in the basin with published discharge data.



Clark Fork River

Bureau of Land Management

TABLE 2.1-55 WATER QUALITY CHARACTERISTICS OF MAJOR STREAMS CROSSED--COLUMBIA RIVER BASIN

Stream Crossing		Period of Record or Date	State Classification	Temperature (°C)		pH		Dissolved Oxygen (mg/l)		Specific Conductance (rmhos/cm)		Dissolved Solids (mg/l)	
Name	Station Number			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Yakima	12482600	1971-1975	A	7.8	0.8-19.6	7.4	6.5-7.9	11.8	8.8-14.7	69	48-100	48	9-131
Columbia	12462600	1971-1978	A	11.4	2.1-20.1	7.9	6.4-9	12.3	9.3-16	156	114-220	107	72-166
Rocky Ford	BOR 1119-770608	1964-1978		11.1	1.5-18	8	7.7-8.4	9.6	6.9-17	389	340-480	No Data	No Data
Crab Creek	12467000	1961-1962	B	10.4	2.1-22	8	7.2-8.8	12.1	9.7-16	498	454-617	323	175-400
St. Joe	SJ4010	1970-1972	A	14.8	1 -26	7.4	7. -8.3	10.3	6.4-13	40.8	23- 57	No Data	No Data
S.Fork Coeur d'Alene	12413490	1973-1976	--	8.9	0.5-20	6.4	4.4-7.4	10.8	7-12.9	292	86-602	216	56-391
Prichard	Near Murray, ID	1974-1977	-	8.8	4 -18.0	7.1	6.3-7.5	-	-	24.4	14- 38	-	-
Thompson	12389500	1975-1976	B-D_1	7.0	4 -10	8.1	7.9-8.3	11.5	10.6-12.6	127.5	85-165	82.8	60-102
Clark Fork	12391000	1969-1973	-	8.9	0 -22	7.9	6.7-8.5	11.0	7.4-14.4	204.4	190-260	128.3	81-285
Clark Fork	12389000	1969-1970	-	8.5	0 -20	8	7.4-8.3	10.6	8 -12.5	208	140-260	126	82-158

Source: EPA STORET data and U.S. Geological Survey.

1/ Table includes published water quality data for the larger streams in the Columbia River Basin.

Prichard Creek (pipeline mile 435-441)

Prichard Creek would be crossed two times within 6 river miles by the proposed route. The first crossing would be near the town of Murray, Idaho, where the stream flows over dredged alluvial materials. The stream in the vicinity of the second proposed crossing flows over alluvial gravels, cobbles, and boulders. Discharge is highly variable both seasonally and annually. Peak flows occur anytime from December through February from a combination of rainfall and snowmelt. Low flows may occur anytime from late summer through early winter. Maximum scour depth is estimated to be 5 feet for the upper reaches of Prichard Creek. Water quality and discharge EPA STORET data, are presented in tables 2.1-54 and 2.1-55 for a station near Murray. State classification of water quality is indeterminate, however, data indicate excellent quality water.

Clark Fork River (pipeline mile 464-496)

The Clark Fork River would be crossed five times within approximately 37 river miles by the proposed pipeline. The first crossing (mile 464) is of a gently curving single channel on a wide alluvial valley. Natural hydraulic and physical characteristics are modified by a dam located about 2 miles downstream at Thompson Falls. The sand and clay west bank is vegetated with conifers, while the sand and gravel east bank has a sparse grass and scattered conifer cover. Both banks appear stable.

The river is entrenched in a deep glacial valley, flowing around a group of alluvial islands at the next three crossings (pipeline miles 470, 470, 471). The pipeline would first cross the main channel from the north valley wall to a large island; then from the island across a side channel to a second island; and finally from the second island across another side channel to the south valley wall. Undercutting and slumping of the banks are contributing sand to the stream sediment load. The rip-rapped west bank at the last crossing is stable.

The fifth crossing (pipeline mile 496) is proposed for a straight single channel just downstream of a gentle meander. The river is situated in pasture grass and scattered tree-covered glacial-alluvial valley. Additional scour could occur during high flows at this site caused by a bridge located immediately upstream of the crossing. Medium-grained sands and sandy gravels are added to the stream sediment load during high flows from the rivers undercutting and slumping banks along this reach.

Stream crossing characteristics, discharge data, and water quality data for the Clark Fork River crossing are included in tables 2.1-53, 2.1-54, and 2.1-55, respectively.

Thompson River (pipeline mile 468)

The Thompson River would be crossed about 6 miles upstream from Thompson Falls. Aerial photo review indicates a moderately fast flowing river approximately 100-feet wide at the crossing. Steep sand, gravelly loam and clay banks with moderate vegetative cover appear stable. Discharge data for the Thompson River are included in table 2.1-54.

Water quality, classified B-D_1 (Montana Department of Health and Environmental Science 1974), is shown in table 2.1-55.

Blackfoot River (pipeline mile 567)

The Blackfoot River is characterized by an irregular meander pattern on a narrow alluvial valley in the vicinity of the proposed crossing. The pipeline would cross at a gentle curve of the channel, through a fast flowing riffle area. The east bank consists of a shallow gravel and cobble highwater area during low flow periods, which is bordered by a stable, vegetated, sand and gravel bank. A stable grass and tree covered bank borders the river on the west.

Detailed stream crossing characteristics and discharge data are included in table 2.1-53 and 2.1-54, respectively. Water quality data are unavailable.

Columbia River Basin--Ground Water

The Columbia Basin can be divided into three major ground water regions, the Cascade Range (pipeline mile 145-180), the Columbia Basalt Plateau (pipeline mile 180-370), and the Northern Rocky Mountains (pipeline mile 370-640).

The Cascade Range aquifers are relatively shallow, unconfined, permeable zones in the alluvial deposits, and weathered bedrock. Saturated materials in the weathered bedrock regions are from 0 to 50 feet below land surface, while the alluviated regions have water at varying depths. Yields of these aquifers are relatively low, however, discharge from numerous springs supplies streams during periods of low flow.

Recharge to both the weathered zone and alluvial aquifers is directly from streams, rainfall, snowmelt, runoff, and in some areas, irrigation water. Discharge is to streams and springs. Groundwater is used primarily for irrigation, with some domestic supplies extracted from individual wells. Chemistry of the water in the weathered bedrock and alluvial aquifers is typically calcium-magnesium bicarbonate with dissolved solids generally less than 300 mg/l (PNRBC 1970).

The principal aquifer in the Columbia Basalt Plateau region, pipeline mile 180-370, is confined in the basalt, however, surficial alluvial and eolian deposits have perched-water zones within 30 feet of the ground surface (Newcomb 1972).

Perched ground-water conditions result from percolation of irrigation or other surface water through the permeable materials to the top of the less permeable basalt (Nassar and Walters 1975). Areas along or immediately adjacent to the alignment where perched ground-water (water-logging) conditions are reported to occur are between pipeline mile 225 and 275 (see Map Addendum). Land use and permeable overlying materials indicate that zones of shallow water probably exist between pipeline mile 275 and 370. The proposed route passes within 2 miles of Coeur d'Alene Lake, pipeline mile 386, which is a recharge basin for the Spokane-Rathdrum prairie aquifer. That aquifer is the sole source of drinking water for public supplies and individual wells in Kootenai County, Idaho, and Spokane County, Washington (Environmental Protection Agency 1978b). Recharge to unconfined-aquifer zones is from rainfall and irrigation water. Discharge is from springs in areas of relief caused by stream incision. Ground water is used primarily for irrigation supply and secondarily for domestic needs.

Chemical analyses of water from eight wells adjacent to the pipeline route indicate that the Columbia River Basalt ground water in the area is generally of a calcium-sodium bicarbonate type. Dissolved solids range from 208 to 527 mg/l, and the specific conductance from 220 to 768 micromhos/cm. Waters are generally hard, ranging from 86 to 302 mg/l of calcium carbonate. Nitrate concentrations range from 0.7 to 56 mg/l, with high values probably indicating some localized contamination of the water. High nitrate concentrations (greater than 10 mg/l) in ground water make it unpotable as stated in Environmental Protection Agency drinking water supply regulations. The ground water is also slightly alkaline, and some wells probably contain dissolved hydrogen sulfide gas (Newcomb 1972). These well waters contain moderately high dissolved silica concentrations (44 to 54 mg/l), that might interfere with potential industrial use of the water (Newcomb 1972).

The Northern Rocky Mountains, pipeline mile 370-640, have three general types of aquifer materials: pre-Tertiary rocks, Tertiary sedimentary rocks, and alluvial and glacial deposits. Generally, the pre-Tertiary and Tertiary materials make fair to poor aquifers which have low storage and yield. An exception to this is some of the coarse-grained Tertiary sedimentary deposits that may produce moderate to moderately large supplies of water (PNRBC 1970, App. V., Vol. 1, p. 199). The alluvial and glacial materials deposited in intermontane valleys yield moderately large quantities of water depending upon their extent. Significant alluvial ground-water accumulations are in the vicinity of Thompson Falls, and Plains, Montana.

Recharge to all of the aquifers in this region is from rainfall and snowmelt and several of the streams are supplied by aquifer baseflow discharge. Very little ground water is used in the mountainous region. However, surface water, which is used for domestic and recreational purposes, is directly supplied from ground-water sources.

The chemical quality of ground water in the Northern Rocky Mountains is relatively good, having dissolved-solids concentrations that range from 200 to 500 mg/l. Water from the alluvial materials is of good to excellent quality, having dissolved-solids concentrations of less than 200 mg/l (PNRBC 1970).

Missouri River Basin--Surface Water Hydrology

The proposed pipeline route crosses the Missouri River Basin from the Continental Divide (pipeline mile 640) through Montrail County, North Dakota (pipeline mile 1180). Sixteen crossings of 11 major streams are proposed for the basin (see Map Addendum and table 2.1-56.

Characteristics for selected streams in the Missouri River Basin are summarized in table 2.1-57. Data are based on field investigations made during the summer of 1978. Low flow and 100-year-flow channel widths and expected time of occurrence are interpreted from records of gauging stations near the proposed crossings.

Estimated stream discharge data are included in table 2.1-58. Instantaneous minimum and maximum discharges recorded in cubic feet per second for the period of record and for the 1976 water year are recorded, if available. The most current year of record is used for stations that were discontinued before the 1976 water year. Mean monthly discharge for April through November, the pipeline construction period, are based on 1976 or most current year of record. All discharge measurements are taken from U. S. Geological Survey published records, except where noted.

TABLE 2.1-56 MAJOR STREAM CROSSINGS--MISSOURI RIVER BASIN

State and County	Stream	Pipeline Mile
Montana		
Broadwater	Missouri	690
Meagher	S. Fork Smith	730
Meagher	S. Fork Smith	733
Wheatland	N. Fork Musselshell	757
Wheatland	Haymaker	764
Petroleum	Flatwillow Creek	843
Petroleum	Flatwillow Creek	848
Petroleum	Flatwillow Creek	870
Petroleum/Garfield	Musselshell	874
Garfield	Big Dry Creek	905
Garfield	Big Dry Creek	940
Garfield	Big Dry Creek	956
McCone	Redwater	1015
Richland/Roosevelt	Missouri	1072
North Dakota		
Williams	Little Muddy	1100
Montrail	White Earth	1140

Missouri River (pipeline mile 690)

At the proposed crossing the Missouri River is characterized by two channels separated by a densely vegetated island. The sandy clay loam banks are vegetated with grasses and scattered trees. Undercutting and slumping of the banks is contributing sediment to the stream. High flows are regulated somewhat by the highway bridge located about 500 feet upstream and by the Canyon Ferry Reservoir located immediately downstream of the crossing. Detailed river crossing characteristics and discharges are included in tables 2.1-57 and 2.1-58, respectively.

The Missouri River is classified B-D_1 (Montana Department of Health and Environmental Science 1974). Water quality data are included in table 2.1-59.

South Fork Smith River (pipeline mile 730-733)

The South Fork Smith River meanders over a large intermontane valley in the vicinity of the proposed route. Two crossings are proposed within about 6 river miles. Aerial photo review indicates the stream is approximately 50 feet wide, relatively shallow, and has low velocities. The gravelly loam, gravelly fine sand, and sandy loam banks appear stable.

The South Fork River is classified B-D_1 by the Montana Department of Health and Environmental Science indicating intermediate quality.

North Fork Musselshell River (pipeline mile 757)

The North Fork Musselshell would be crossed just above its confluence with the South Fork Musselshell River near Martinsdale, Montana. Aerial photo review indicates the stream is slow and meandering, about 100 feet wide on a broad floodplain. The clay loam and silty clay loam stream banks appear stable. Discharge data for the North Fork Musselshell are included in table 2.1-58.

Although no water quality data are available, the State of Montana has classified the North Fork of the Musselshell B-D_1 indicating intermediate water quality.

Haymaker Creek (pipeline mile 764)

Haymaker Creek is characterized by a sinuous channel in a relatively wide south-trending valley. The proposed crossing would be at a stream meander. Although no recent lateral migration was observed, cutoff potential exists. Dense grass and brush is protecting the stream banks from active erosion. River crossing characteristics based on a July 1978, inspection are in table 2.1-57. No discharge data are available for Haymaker Creek, however, low flows would be anticipated anytime from late summer through winter, and peak flows expected in late spring or summer.

The state of Montana has classified Haymaker Creek B-D_1 indicating intermediate quality water suitable for beneficial and natural resource uses.

Flatwillow Creek (pipeline mile 843-870)

Flatwillow Creek is meandering over a flat sand, silt, and gravel filled alluvial valley at the three proposed crossing locations. The river would be crossed at relatively straight transitional sections between meander bends. Some potential for meander cutoff exists. The banks are stable at the first two crossing locations (pipeline mile 843 and 848) with dense growth of willows protecting the clay banks. Undercutting and slumping is occurring at the third proposed crossing (pipeline mile 870), contributing sand and silt to the stream sediment load. Vegetation along the banks consists of scattered patches of cottonwoods. Detailed river crossing characteristics and discharges are presented in tables 2.1-57 and 2.1-58, respectively.

Musselshell River (pipeline mile 874)

The Musselshell River is characterized by a sinuous channel situated on a sand and gravel-filled valley. Lateral activity, cutoff, and oxbow lake development is occurring. The pipeline would cross at a gentle meander of the river. Active erosion appears to be occurring on the nearly vertical unvegetated west bank, while the silt and clay east bank is stable. Meander migration to the west would probably continue unless the bank was stabilized. Detailed river crossing characteristics and discharges are presented in tables 2.1-57 and 2.1-58, respectively.

The Musselshell River is classified as B-D_3 according to Montana State Water Use classification. Sediment loads up to 3,050 mg/l have been recorded and are included in table 2.1-59.

Big Dry Creek (pipeline mile 905-956)

Big Dry Creek's intermittent flow is confined to a single sinuous channel at the three proposed crossing locations. Some undercutting and slumping of the stream

TABLE 2.1-57 CHARACTERISTICS OF SELECTED STREAM CROSSINGS--MISSOURI RIVER BASIN

Stream Crossing Name	Pipeline Mile	Survey Date	Width (feet)	Depth (feet)	Velocity (ft/sec)	Gradient (ft/100ft)	Scour Depth (feet)	100 Year Flow		Low Flow		Stream Bed Composition
								Max.Width (feet)	Expected Occurrence	Max.Width (feet)	Expected Occurrence	
Missouri	690	7/78	600	5	2-3	0.2	3-5	1600	May-June	400	Sept.-Feb.	Sand, gravel, cobbles
Haymaker	764	7/78	5	1	1-2	0.2	3	170	Mar.-May	2	Sept.-Feb.	Sand, gravel
Flatwillow Ck.	843	7/78	25	5	2-3	.01	3-4	600	June	0	Aug.-Feb.	Clay, silt, sand gravel
Flatwillow Ck.	848	7/78	25	5	2-3	.01	3-4	1500	June	0	Aug.-Feb.	Clay, silt, sand, gravel
Flatwillow Ck.	870	7/78	120	1-2	2-3	0.2	7	1000+	April-June	0	Aug.-Feb.	Silt, sand, gravel
Musselshell	874	7/78	250	3-4	2	0.25	7	1500	Mar.-June	0	Sept.-Feb.	Sand, gravel
Big Dry Ck.	905	7/78	0	0	0	0.2	0	250	Any month	0	Sept.-Feb.	Clay, silt, sand
Big Dry Ck.	940	7/78	75	6	1-2	0.1	8-10	1500	Any month	0	July-Feb.	Sand, gravel
Big Dry Ck.	956	7/78	85	1	1-2	0.1	10-12	2000	Any month	0	July-Feb.	Sand, gravel
Redwater	1015	7/78	75	1-2	1	0.1	7-8	1000	Mar.-Aug.	0	Sept.-Feb.	Sand, gravel
Missouri	1072	7/78	450	15	2	.02	15	700	Any month	200	Aug.-Jan.	Sand, gravel
Little Muddy	1100	7/78	30+	3	1	0.1	2-3	400	Mar.-April	0	Aug.-Feb.	Clay, silt, sand

Source: Adapted from stream crossing reports prepared for Northern Tier Pipeline Company.

[1/] Table includes the streams in the Missouri River Basin requiring special individual or group permits under the discretionary authority of the U.S. Army Corps of Engineers or requiring Section 10 permits.

TABLE 2.1-58 ESTIMATED WATERSHED DISCHARGE DATA--MISSOURI RIVER BASIN[1/]

Stream Crossing		Period of Record	Extremes (cfs)					Means (cfs)									Average Discharge
			Pd. of Record		Most CY Data												Period of Record (cfs)
Name	Station No		Min.	Max.	Min.	Max.	Year	Year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	
Missouri	06054500	1890-1976	562	32,000	2,300	23,300	1976	1976	8814	18,400	15,050	6387	4072	5273	6217	6296	5401
North Fork Musselshell	06115500	1940-1976	1.6	423	3.6	58	1976	1976	23.6	39.6	22.9	9.6	5.5	4.6	8.2	11.4	12.2
Flatwillow C.	06130000	1964-1966	No Flow	3,580	0	1,180	1966	1966	75.4	23.4	4.34	3.61	.052	0	8.79	13.1	
Musselshell	06130500	1929-1976	No Flow	18,000	76	2,300	1976	1976	313	1673	735	239	162	174	304	280	268
Big Dry Creek	06131000	1939-1976	No Flow	24,600	0.6	1,220	1976	1976	9.4	7.9	120	7.8	12.2	1.4	10.3	3.3	52.4
Redwater	06177825	1975-1976	2.0	3,500	2.0	3,500	1976	1976	35.3	12.1	178	167	6.7	2.9	4.86	5.01	57.8
Missouri	06185500	1941-1976	575	78,200	8,200	32,900	1976	1976	18,080	14,770	23,550	17,190	14,580	14,760	14,520	14,840	10,780
Little Muddy	06331000	1954-1977	.2	6,910	4.4	64	1977	1977	17.7	14.4	9.13	5.54	5.24	7.26	10.5	11.3	36.5
White Earth	06332000	1954-1977	No Flow	2,370	0.09	103	1977	1977	12.2	11.1	6.3	1.66	1.89	5.20	4.10	3.2	27.7

Source: U. S. Geological Survey.

[1/] Table includes published discharge data for the larger streams in the Missouri River Basin. No data were found for the South Fork Smith River and Haymaker Creek.

banks at the proposed crossings is contributing clay loam soil to the stream sediment load. Detailed stream crossing characteristics are included in table 2.1-57.

Flow is extremely variable in Big Dry Creek. Peak flows have occurred through the year corresponding to snowmelt runoff, long duration spring rains, or high intensity summer thunderstorms. Low flow or no flow periods generally occur during the summer, fall, and winter months. Discharge data for a gauging station located near the third proposed crossing (mile 956) are included in table 2.1-58. Water quality data are included in table 2.1-59.

Redwater River (pipeline mile 1015)

The Redwater River meanders over a relatively wide sand and gravel filled alluvial valley of rangeland and cultivated fields. The pipeline would cross the river in a riffle area between two meanders. Dense vegetation is protecting the stream banks from active erosion during normal flows. Under flood conditions, however, sediment would be contributed by undercutting and slumping of the east bank. Detailed river crossing characteristics and discharges are presented in tables 2.1-57 and 2.1-58, respectively.

Water quality data and classifications are included in table 2.1-59.

Missouri River (pipeline mile 1072)

The Missouri River would be crossed at a straight river section just downstream of a gentle meander. Flow along this section is highly regulated by Fort Peck Reservoir located upstream of the proposed crossing. The sand and silt south bank is actively eroding contributing sediment to the stream. Scattered patches of cottonwoods and pastureland vegetation have stabilized the north bank, so no active erosion is evident. Detailed river crossing characteristics and discharges are included in tables 2.1-57 and 2.1-58, respectively.

Water quality data and classifications are included in table 2.1-59.

Little Muddy River (pipeline mile 1100)

The Little Muddy River meanders over a broad, flat, oversized valley. Flow is confined to a single channel at the proposed crossing. Lateral migration of the stream is controlled by a dike along the west bank above the alignment. The stratified sand and silt streambanks are protected from erosion by grass and weed vegetation. Detailed river crossing characteristics and discharge data are included in tables 2.1-57 and 2.1-58.

The state of North Dakota has classified the Little Muddy River Class II. Selected water quality data are included in table 2.1-59.

White Earth River (pipeline mile 1140)

The sinuous channel of the White Earth River would be crossed by the proposed route near the town of White Earth, North Dakota. Based on aerial photo interpretation the stream is approximately 35 feet wide, shallow, and slow moving. Discharge is regulated by White Earth Reservoir located about 20 to 25 river miles upstream. The loam, silty clay loam, and clay loam banks are vegetated, however some undercutting and slumping is probably occurring as evidenced by lateral activity.

Missouri River where it enters Canyon Ferry Lake near Townsend, Montana. BLM

TABLE 2.1-59 WATER QUALITY CHARACTERISTICS OF MAJOR STREAMS CROSSED--MISSOURI BASIN

Stream Crossing		Period of Record or Date	State Classification	Temperature (°C)		pH		Dissolved Oxygen (mg/l)		Specific Conductance (umhos/cm)		Dissolved Solids (mg/l)	
Name	Station Number			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Missouri	06058502	1967-1978	B-D_1	8.3	0.5-17	7.9	7-8.4	9.8	7.7-11.7	348	300-476	222	185-282
Musselshell	06130500	1974-1977	B-D_3	9.7	0-24.5	8.2	7.8-8.6	10	7-13	1996	1000-3400	1610	705-3050
Big Dry Creek	298005	1968-1977	--	8.1	0-29	8.6	7.7-9.2	10.0	6.5-13.5	2369	279-5600	1651	330-3262
Redwater	06177825	1976	B-D_3	No mean	0.5-25	No mean	7.8-8.3	No mean	6.2-12.7	No mean	812-4250	No mean	531-3990
Missouri	06185500	1965-1976	B-D_3	8.5	0-24.5	No mean	7.9-9.0	No mean	7.4-11.7	635	338-807	No mean	316-445
Little Muddy	06331000	1971-1978	II	No mean	0-24	No mean	7.6-8.7	No mean	No mean	No mean	220-3450	No mean	154-1760
White Earth	330055	1973-1977	II	11.8	1-26	7.9	7.0-8.8	9.2	6.2-14.3	1424	1328-1520	1281	1000-1454

Source: EPA STORET data and U.S. Geological Survey.

[1] Table includes published water quality data for the larger streams in the Missouri River Basin. No data were found for the South Fork Smith River, North Fork Musselshell River, Haymaker Creek, and Flatwillow Creek.

Discharge and water quality data are presented in tables 2.1-58 and 2.1-59, respectively.

Missouri River Basin--Ground Water

The Missouri River Basin, pipeline mile 640-1180, includes part of the Northern Rocky Mountain, the Border, and the Great Plains regions.

The Northern Rocky Mountain region includes parts of the Columbia and Missouri Basins. Aquifer characteristics are discussed in Columbia Basin--Ground Water.

The border region, pipeline mile 710-745, is a transition zone between the mountainous region of western Montana and the area of low relief in central and eastern Montana known as the Great Plains. Water-bearing zones in the region are found in unconsolidated alluvium and in sedimentary rock basins formed between the mountains. Aquifers in the alluvium are usually unconfined, may be as thick as 140 feet, and have water levels that range from 10 to 50 feet below the ground surface. There are alluvial valleys, underlain by significant aquifers, in the Helena-Townsend area, pipeline mile 645-690. Saturated zones in the sedimentary rock basins are in permeable sandstone units that are commonly bounded by impervious shale. In areas where shale overlies a saturated sandstone and prevents the free upward migration of water, confined (artesian) ground-water conditions exist. Depth to water-bearing materials in the sedimentary units ranges from a few hundred to more than a thousand feet. However, depth to water may be shallower if artesian conditions are encountered. In fact, artesian pressures cause some wells to flow at the surface.

Recharge to the unconfined alluvial aquifers is primarily from precipitation, while the confined aquifers receive most of their recharge from streams that flow over areas where permeable beds crop out.

Water quality in the unconfined zone is highly variable depending upon the amount of water circulation within the aquifer and/or the proximity to shale beds. Dissolved solids range from 70 to 14,000 mg/l and the general chemical character of the water is sodium sulfate or sodium bicarbonate with varying degrees of mineralization and resultant hardness. The confined aquifers have dissolved solids that range from 500 to 1,500 mg/l in sampled wells. The chemical character of artesian well water is primarily sodium bicarbonate and sulfate (USGS 1968).

The Great Plains region, pipeline mile 745-1180, is typified by relatively flat lying sedimentary rock units with local surficial deposits of alluvium and glacial gravel (USGS 1968). Aquifers in both the rock units and overlying unconsolidated deposits are unconfined in most of the region. The sandstone units of the Fort Union and Lance Formations, and the surface gravel, are the principal aquifers in the region.

The gravel deposits are commonly less than 100 feet thick and have water levels within 10 to 20 feet of the surface in river and stream channels. Wells in the Fort Union and Lance Formations usually encounter water-bearing materials within 200 or 300 feet of the surface and there are several only 100 feet deep. Water levels in these wells are usually within a few feet of the level at which water was first encountered.

Recharge to the consolidated and unconsolidated materials is from precipitation and from streams after periods of heavy rainfall. Most streams that cross permeable units of the Fort Union and Lance Formations do not have perennial surface flow because they readily recharge the underlying aquifers. Natural discharge is limited to a few springs in the unconsolidated materials. Most of the discharge is from wells which produce water for domestic and livestock uses.

Water quality in the unconfined zone is highly variable depending upon the amount of water circulation within the aquifer and/or the proximity to shale beds. Dissolved solids range from 700 to 14,000 mg/l and the general chemical character of the water is sodium sulfate or sodium bicarbonate with varying degrees of mineralization and resultant hardness. The confined aquifers have dissolved solids that range from 500 to 1,500 mg/l in sampled wells. The chemical character of artesian well water is primarily sodium bicarbonate and sulfate (USGS 1968).

Souris-Red River Basin--Surface Water

The proposed pipeline route crosses the Souris-Red River Basins from Ward County, North Dakota (mile 1180), through Clearbrook, Minnesota (mile 1491). Six crossings of four major streams that would be crossed in the basin are included in the Map Addendum and table 2.1-60.

TABLE 2.1-60 MAJOR STREAM CROSSINGS--SOURIS-RED RIVER BASINS

State and County	Stream	Pipeline Mile
North Dakota		
Ward	Des Lacs	1197
Ward	Souris	1201
McHenry	Souris	1248
North Dakota/Minnesota		
Grand Forks/Polk	Red River of the North	1416
Minnesota		
Polk	Red Lake River	1422
Polk	Red Lake River	1441

Source: BLM 1979

Detailed stream crossing characteristics for selected streams in the Souris-Red Basin are summarized in table 2.1-61. Data is based on field investigations during the summer of 1978. Low flow and 100-year-flow channel widths and expected time of occurrence are interpreted from gauging station records near the proposed crossings.

Estimated stream discharge data are included in table 2.1-62. Instantaneous minimum and maximum discharges recorded in cubic feet per second (cfs) for the period of record and for the 1976 water year if available. The most current year of record is used for stations that were discontinued before the 1976 water year. Mean monthly discharges for April through November, the pipeline construction period, are based on

TABLE 2.1-61 CHARACTERISTICS OF SELECTED STREAM CROSSINGS--SOURIS-RED RIVER BASINS[1]

Stream Crossing Name	Pipeline Mile	Survey Date	Width (feet)	Depth (feet)	Velocity (ft/sec)	Gradient (ft/100ft)	Scour Depth (feet)	100 Year Flow Max.Width (feet)	100 Year Flow Expected Occurrence	Low Flow Max.Width (feet)	Low Flow Expected Occurrence	Stream Bed Composition
Souris	1,201	7/78	120	12	< 1	0.01	0	1000	Feb-April	0	Sept-Feb	Clay, silt, Sand, gravel
Red	1,416	7/78	160	22	< 1	0.01	2	300	April	40	Sept-Feb	Silt, clay
Red Lake	1,422	7/78	130	9	2	0.02	5	400	Mar-May	40	Aug-Sept	Silt, sand
Red Lake	1,441	7/78	180	4	1	0.02	3-5	350	Mar-May	160	Aug-Sept	Sand, gravel

Source: Adapted from stream crossing reports prepared for Northern Tier Pipeline Company.

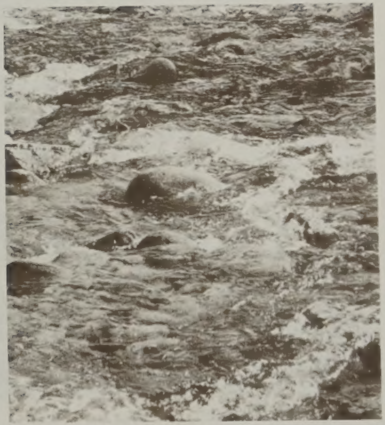
[1] Table includes the larger streams in the Souris-Red River Basins requiring special individual or group permits under the discretionary authority of the U.S. Army Corps of Engineers or requiring Section 10 permits.

TABLE 2.1-62 ESTIMATED WATERSHED DISCHARGE DATA--SOURIS-RED RIVER BASINS[1]

Stream Crossing Name	Stream Crossing Station No	Period of Record	EXTREMES (cfs) Pd. of Record Min.	EXTREMES (cfs) Pd. of Record Max.	EXTREMES (cfs) Most CY Data Min.	EXTREMES (cfs) Most CY Data Max.	EXTREMES (cfs) Most CY Data Year	Means (cfs) Year	Means (cfs) April	Means (cfs) May	Means (cfs) June	Means (cfs) July	Means (cfs) Aug.	Means (cfs) Sept.	Means (cfs) Oct.	Means (cfs) Nov.	Average Discharge Period of Record
Des. Lacs	05116500	1945-1976	No Flow	3,660	3.6	1,550	1976	1976	730	307	135	50.4	13.5	6.70	83.5	50.7	32.6
Souris	05117500	1903-1976	No Flow	12,000	16	9,350	1976	1976	6,209	2,872	679	763	435	121	186	153	170
Souris	05120000	1937-1976	0.3	9,900	25	9,900	1976	1976	6,280	3,639	683	796	512	154	199	169	219
Red	05082500	1887-1976	2.4	80,000	506	23,600	1976	1976	9,237	2,515	1,556	1,106	976	700	2345	2315	2,524
Red Lake	05079000	1901-1976	No Flow	28,400	479	12,500	1976	1976	3,409	1,340	1,149	915	991	669	1966	1604	1,121

Source: U.S. Geological Survey

[1] Table includes the larger streams in the basin with published discharge data.



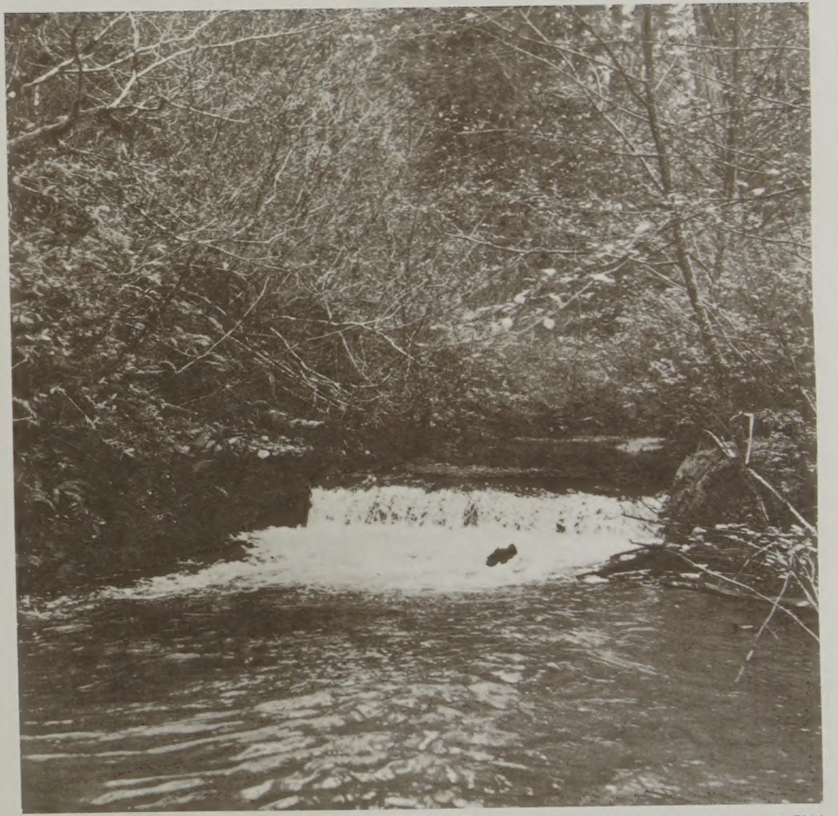
Bureau of Land Management

TABLE 2.1-63 WATER QUALITY CHARACTERISTICS OF MAJOR STREAMS CROSSED--SOURIS-RED RIVER BASINS

Stream Crossing		Period of Record or Date	State Classification	Temperature (°C)		pH		Dissolved Oxygen (mg/l)		Specific Conductance (umhos/cm)		Dissolved Solids (mg/l)	
Name	Station Number			Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Souris	05120000	1952-1976	IA	--	0-28	--	7.5-8.5	--	--	--	435-2070	--	165-1550
Red	05082500	1944-1978	I&IC	--	0-27	--	7.0-8.7	--	--	--	200- 976	--	170- 475
Red Lake	CSAH-15 @Fisher	1955-1965	IC	12.2	0-27	7.8	6.9-8.7	7.8	3.4-12	--	--	--	--
Red Lake	05079000	1974-1976	IC	5	0-23	8.3	6.9-8.7	--	--	360	195- 470	184	126- 278

Source: EPA STORET data.

[1] Table includes published water quality data for the larger streams in the Souris-Red River Basins. No data were found for the Des Lacs River.



Typical of the many small streams which support resident trout.

BLM

1976 or most current year of record. All discharge measurements are taken from USGS published records, except where noted.

Des Lacs River (pipeline mile 1197)

The sinuous channel of the Des Lacs River would be crossed about 5 miles upstream of its confluence with the Souris River near Minot, North Dakota. Numerous meander scars and oxbow lakes are present in this area. The 90-foot wide stream channel meanders over a 750-foot wide flood plain, based on aerial photo interpretation. A small impoundment downstream from the crossing has created a backwater area at or near the proposed alignment.

Discharge and water quality data are presented in tables 2.1-62 and 2.1-63, respectively.

Souris River (pipeline mile 1201-1248)

The Souris River would be crossed near the towns of Minot and Towner, North Dakota. The sinuous channel is incised into a relatively narrow valley. The proposed crossings are in straight river reaches between meanders. Lateral activity appears to be in the form of cutoffs rather than migration. All banks appear to be stable with dense grass and brush vegetation from waters edge to bank top. Detailed river crossing characteristics and discharges are summarized in tables 2.1-61 and 2.1-62, respectively.

Selected water quality data and North Dakota state classification are presented in table 2.1-63. The town of Minot, North Dakota, utilizes the Souris River for part of their municipal water supply.

Red River (pipeline mile 1416)

The Red River is characterized by a carved channel meandering across a broad flat valley. Old meander scars are apparent both above and below the proposed crossing, which is located at a curving section of the channel. The silt and clay banks are stable, covered with dense growths of hardwoods and brush. Detailed river crossing characteristics and discharge data are included in tables 2.1-61 and 2.1-62, respectively.

The state of North Dakota has rated the Red River Class I, while Minnesota has assigned a IC classification. Selected water quality data are included in table 2.1-63.

Red Lake River (pipeline miles 1422-1441)

The sinuous Red Lake River channel would be crossed near the towns of Fisher mile 1422) and Gentilly (mile 1441), Minnesota. The stream near Fisher, Minnesota, is entrenched into a broad flat lake plain. Many oxbow lakes resulting from meander loop cutoffs are present near the crossing which is proposed for a relatively straight stretch of the river. The clay banks are buffered from water erosion by dense grass, weed, and brush cover. Old meander scars and oxbow lakes are present or the rolling valley near Fisher, Minnesota. The pipeline would cross the river at a gentle meander. Heavy weed, grass, and brush cover protects the stable sand and silt streambanks. Detailed river crossing characteristics and discharge data from the proposed crossings are included in tables 2.1-61 and 2.1-62, respectively.

The state of Minnesota has classified the Red Lake River suitable for fisheries and recreation, industrial consumption, agricultural, wildlife and other uses. Select water quality data are included in table 2.1-63.

Souris-Red River Basins--Ground Water

The Souris-Red River Basins, pipeline mile 1180-1491, consists of the Pierre Shale, Dakota Sandstone, and glacial drift regions of the Central Lowlands province.

The Pierre aquifer is in the upper part of the Pierre Shale, and consists of shale, marlstone, and claystone. The formation is nearly impermeable and will not yield a significant amount of water to wells except from fractures that form the aquifer. The fractures, where present, may extend several hundred feet below the surface, but they generally are too small to yield significant quantities of water at depths of more than about 100 feet (North Dakota Geological Survey 1973).

The Dakota aquifer underlies all of North Dakota except for a narrow strip of crystalline bedrock along the eastern edge adjacent to the Red River. The water in the Dakota aquifer in most of eastern North Dakota is under artesian pressure that is great enough to cause wells penetrating it to flow at the surface. Sandstone of the Dakota Formation has low yields (5 to 50 gallons per minute), is relatively hard and high in iron, and saline.

The glacial drift aquifers are the most important source of ground water in the state. The size and shape of each aquifer depends on the environment in which the materials were deposited. Glacial-drift aquifers include: 1) buried sand and gravel deposits, 2) surficial sand and gravel deposits, and 3) glacial till. The buried aquifers include outwash-channel fill, outwash-plain deposits, and ice-contact deposits. The surficial sand and gravel aquifers include outwash plains, exposed outwash-channel deposits, terrace deposits, and at least one esker. The water-bearing characteristics of glacial till are controlled by the presence of sand and gravel lenses, disseminated sand and gravel, and fractures. The surficial-deposit aquifers and some aquifers in the glacial till are unconfined (North Dakota Geological Survey 1973).

Wells that produce water from glacial drift range in depth from around 100 feet to 450 feet (Randich and others 1963). Those that extract water from fractured shale in the Pierre aquifer are usually less than 200 feet deep. The Dakota Formation, like the other consolidated bedrock units, dips gently to the west. Therefore, wells penetrating to the Dakota Sandstone aquifer range in depth from about 100 feet in eastern North Dakota to more than 1,000 feet in the vicinity of the Missouri River where the proposed pipeline would cross.

Recharge to unconfined materials is derived primarily from rainfall or melting snow and is relatively rapid on the surficial outwash plains, because the soil and underlying material are generally highly permeable. Recharge to unconfined materials is also derived from rivers and streams. To the more deeply confined aquifers recharge is by percolation of rainfall and runoff in areas where the deeper aquifer materials crop out. Ground water is discharged to supply springs, lakes, ponds, and swamps. In general, water levels decline during the summer, early fall, and winter because recharge is reduced and natural discharge increases. Water levels usually rise to or very near the surface during the spring and early summer and again, temporarily, in the fall, when evapotranspiration is small and recharge is comparatively large.

Ground-water use is limited in the eastern portion of North Dakota by the abundance of surface water and the relatively poor quality of ground water (Souris-Red-Rainy River Basins Commission 1972, Appendix B, Vol. 2). Several ranches have shallow wells for domestic and livestock supplies in glacial-drift-filled channel areas and the Pierre aquifer. Petroleum companies use the saline ground water from artesian wells in the Dakota aquifer for injection water in oil wells.

In Minnesota, ground water is available from sand bodies in glacial drift and deposits associated with prehistoric, glacial Lake Agassiz. The Lake Agassiz plain is underlain mainly by clayey to silty sands as much as 150 feet thick. Gravelly sandbars, formed at the sites of former beaches, are discontinuous and linear. Ground water can be obtained from many of these sandy glacial-drift aquifers. In parts of the Lake Agassiz plain, where the ground water circulates through the bedrock and glacial drift, water is unsuitable for human consumption, because of the high chloride content. The shallowest and most dependable aquifers are the gravelly sands of the abandoned beach bars and river-channel alluvium. Ground water from these deposits generally is very hard with high dissolved solid content. Ground-water yields from bedrock in the northern part of the western province are low in both quantity and quality. Because of the marginal to poor quality of ground water and sufficient surface-water supplies, extraction of ground water is minimal. Discharge is small in proportion to recharge, so shallow ground (within 10 feet of the surface) is common in areas to be traversed by the proposed pipeline.

Ground water from glacial-drift aquifers in the Central Lowlands portion of North Dakota and Minnesota has a wide range of water quality. Dissolved-solids concentrations are less than 500 mg/l in areas of best quality and greater than 5,000 mg/l in areas of poorest quality. The water is hard to very hard and either calcium-bicarbonate or calcium-sulfate type. Water from the Pierre Shale is generally sodium-chloride or sodium-sulfate type and has dissolved-solids concentrations that range from 700 mg/l to 12,500 mg/l(North Dakota Geological Survey 1973). The Dakota aquifer dissolved solids concentration averages about 3,500 mg/l but may be as high as 10,000 mg/l or as low as 1,000 mg/l in different wells. The chemical makeup is typically sodium sulfate or sodium chloride with chloride and sulfate-ion concentrations that generally are two to five times the limits recommended by the U.S. Public Health Service.

Biological Components

The biological components within the aquatic environment include fishes, reptiles (snakes and turtles), amphibians (frogs and salamanders), mollusks (snails and clams), crustaceans (crayfish and shrimp), aquatic insects, worms, algae, and bacteria. Their abundance and distribution are influenced by streamflow velocities, bottom characteristics, water temperatures, water quality, predation, and competition. All of these organisms, together with terrestrial insects, are part of the food web within the aquatic environment. Fishes are of major concern in this environment and will be discussed in detail. Insects are also of concern and will be discussed briefly.

Two major groups of fishes are found in waters along the corridor: cold water species and warm water species. Major cold water species include five species of salmon and five species of trout. All of the salmon and three species of trout hatch in freshwater, migrate as juveniles to saltwater where they live until maturity, and return to freshwater as adults to spawn (anadromous or searun). The salmon die after spawning. The other two species of trout spend their life cycle entirely in freshwater. Two species of salmon (coho and sockeye or kokanee) are capable of completing their life cycle entirely in freshwater. The major cold water species have similar spawning habits and requirements. Eggs are deposited in depressions excavated in gravel bottomed streams. The eggs are covered with a layer of gravel and hatching takes place several weeks to months later depending on the species and water temperature. Resident rainbow and cutthroat spawn in the spring, usually from April through July, while brown, brook, and Dolly Varden trout and landlocked coho and kokanee salmon spawn in the fall, usually from September through December. A constant flow of sediment-free, well-oxygenated water and sediment-free gravel are required for successful hatching. Most of the salmon and trout production occurs naturally. However, populations are continually augmented by artificial production at state and federal hatcheries, mostly in western Washington. Juvenile fish are usually released into adjacent streams. Salmon contribute to commercial, sport, and Indian fisheries. Resident trout are limited to freshwater sport angling. Anadromous trout (mostly steelhead) contribute to both the ocean and freshwater sport and Indian fisheries. Cold water species are most important in Washington, Idaho, and western Montana. Some western Washington streams have been identified as significant habitat for these species.

Salmon are emphasized because of their local, national, and international importance to sport, commercial, and Indian fisheries. Treaties and agreements between the United States and foreign countries have been enacted to regulate the commercial fishery for salmon in the Pacific Ocean. In order to maintain the present level of sport and commercial harvest, state and federal hatcheries and spawning channels must compensate for lost natural production through artificial production. The lost natural production has resulted primarily from deterioration and losses in spawning and rearing habitat caused by hydroelectric dam development and land-use practices.

Major warm water species include bass, perch, crappie, walleye, northern pike, and catfish. The spawning habits and requirements of the warm water fishes are different from the cold water fishes. The warm water fishes generally excavate shallow depressions in sandy to muddy bottoms in slow moving streams or impoundments. The eggs are spawned and usually left uncovered. Some species spawn on vegetation or in open water areas where the adhesive eggs settle and stick to vegetation or to the bottom. Eggs usually hatch in a few days to one month, depending on the species and water temperature. Spawning for most species takes place in the spring, usually from April through July. Warm water species can generally tolerate lower water quality and higher turbidities than cold water species and much spawning occurs in areas with little or no current and on sediment covered bottoms. Most warm water fish production occurs naturally but some spawning and rearing does take place at state and federal hatcheries. Most of the warm water species are valued primarily for sport, although some may be commercially important in local areas. Warm water fishes are most important in eastern Montana, North Dakota, and Minnesota.

Forage fishes inhabit most streams and impoundments along the proposed pipeline corridor where cold and warm water fishes are found and in areas unsuitable for major cold or warm water fishes. These forage fishes, primarily minnows and sculpins, serve as food for many of the major cold and warm water fishes. The proposed corridor would cross a variety of streams ranging from small, unnamed, intermittent streams to major rivers such as the Columbia and the Missouri. Virtually all of these streams support some form of fisheries resource. Many of the small streams contain only forage fish while the larger streams contain both forage fish and major

TABLE 2.1-64 FISH OCCURRENCE AND FISHERY VALUE IN SELECTED STREAMS WITHIN MAJOR DRAINAGES

Puget Sound Drainage										
Stream	Pipeline Mile	Fishery Value	Chinook	Coho	Pink	Chum	Sockeye	Steelhead	Other Sea-run Trout	Resident Trout
Siebert Creek	1	H		+	+	+		+	+	+
Dungeness River	7	H	+	+	+	+		+		+
Pilchuck Creek	64	H	+	+	+	+		+	+	+
Armstrong Creek	68	UNKNOWN								
North Fork Stillaguamish River	69	H	+	+	+	+		+	+	+
South Fork Stillaguamish River	70	H	+	+	+	+		+	+	+
Little Pilchuck Creek	82,83	H		+				+	+	+
Pilchuck Creek	86	H	+	+	+	+		+	+	+
Skyomish River	97	H	+	+	+	+		+	+	+
Cherry Creek	105	H	+	+	+	+		+	+	+
Harris Creek	108	H	+	+	+	+		+	+	+
Tolt River	111	H	+	+	+	+		+	+	+
Griffin Creek	115	H	+	+	+	+		+	+	+
Tokul Creek	120	H	+	+				+	+	+
Snoqualmie River	123	H	+	+	+	+		+	+	+
South Fork Snoqualmie River	134	H								+

Columbia River Drainage									
Stream	Pipeline Mile[1]	Fishery Value[2]	Rainbow Trout	Cutthroat Trout	Brook Trout	Brown Trout	Dolly Varden	Steelhead	Salmon
Keechelus Lake	147-152	H	+	+			+		
Meadow Creek	152	M	M	M					
Cabin Creek	160	M	M	M					
Big Creek	165	H	H	H				H	H
Yakima River	182	H	+	+	+	+	+	H	H
Naneum Creek	198	M	M	M					
Coleman Creek	201	M	M	M					
Columbia River	224	H	+	+	+	+	+	H	H
Rocky Ford Creek	253	H	H			H			
Crab Creek	259	H				H			
Rock Creek	344	M	M			M			

Coeur d'Alene River and Clark Fork River Drainages										
Streams	Pipeline Mile	Fishery Value	Cutthroat Trout	Rainbow Trout	Brook Trout	Brown Trout	Dolly Varden	Kokanee	Northern Pike	Spiny Rays (Bass, Perch Crappie)
St. Joe River	386	H	H	+	+			H		
Coeur d'Alene Lake	452	H	H	+	+		+	H		+
Lateral lake tributaries	380-398	M	+	+	+					
Lateral Lakes	380-398	H	M	+						H
Latour Creek	402-407	M	M	+	+					
Coeur d'Alene River	414	H	H		+			H		
Bear Creek	414-421	H	H	M	M					
Prichard Creek	433-443	H	H	H	M			H		
Prospect Creek	444-463	H	H	+	+	H	H			
Clark Fork River	464-496	H	M	+	+		+			
Ninemile Creek	507-527	M	M	M	M					
Blackfoot River	556-567	M	+	+	+					

Missouri River, Souris River, and Red River Drainages														
Stream	Pipeline Mile[1]	Fishery Value[2]	Trout	Northern Pike	Walleye	Channel Catfish	Smallmouth Bass	Coho	Lake Trout	Perch	Sauger	Goldeye	Buffalo	Forage Fish
Missouri River (Canyon Ferry Lake)	690	H	+		+									+
North Fork Musselshell River	757 843	H	H											+
Flatwillow Creek	848, 870	M	M			H	M				H			+
Musselshell River	874	H	H			H	M				H			+
Big Dry Creek (Fort Peck Reservoir)	956	H		H	H									+
Missouri River (Lake Sakakawea)	1072	H	+	H	+	+		+	+	+	+	+	+	+
Little Muddy River	1100	H		M	M	M		+		M				H
White Earth River	1140	H		M	H					M				H
Little Knife River	1157	H		M										H
Des Lacs	1197	H M		H	M					M				H H
Souris River	1201, 1248	H		H										M
Egg Creek	1230	H		H										M
Big Coulee (Mauvais Creek)	1307													
Turtle River	1388- 1391	M		M	M					+				+
Red River	1416	H		M	M	H				M	M	M		+

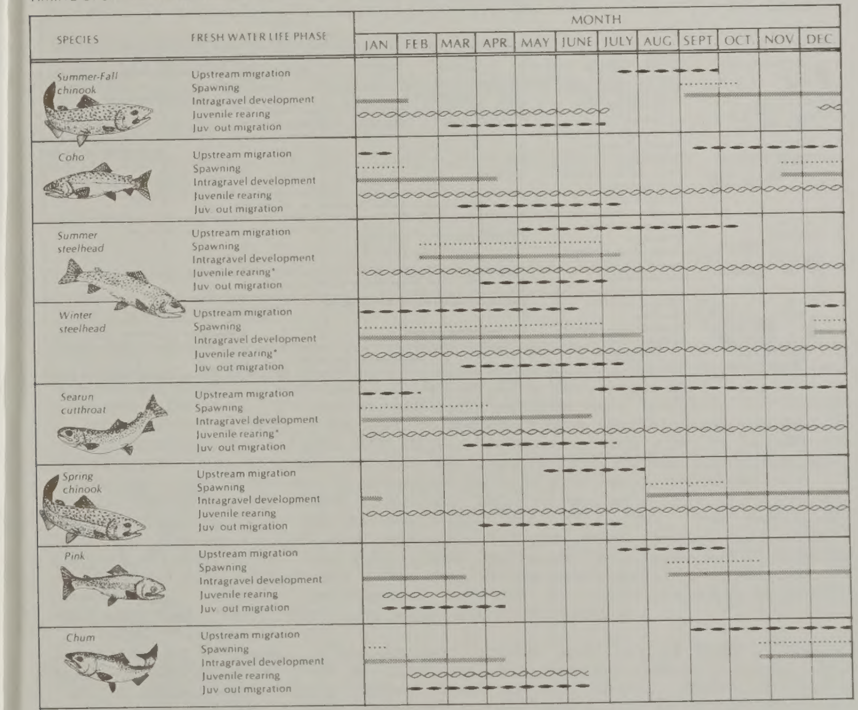
Source: USDI, Fish & Wildlife Service, pers. comm. 1978a, b, f; USDA, Forest Service, pers. comm. 1978 b, g; Washington Department of Fisheries 1975.

[1] Pipeline mile where stream crossing would occur. [2] Overall value of fishery including all species. Value based on following considerations: fish population size, habitat quality, angler preference, access, availability, commercial importance, state and federal stocking, local and regional importance, etc. [3] Only resident trout occur in the crossing area. All other species occur downstream from the crossing.

H = High Value M = Moderate Value + = Species present but not evaluated

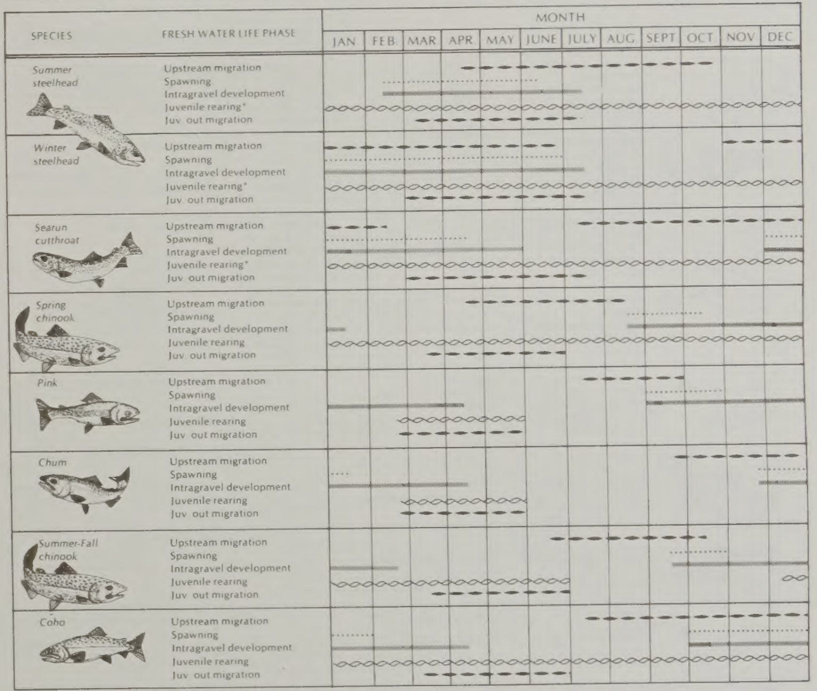
FRESH WATER LIFE HISTORY PHASES OF SALMON AND SEARUN TROUT

TIMING OF SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE DUNGENESS RIVER BASIN AND SIEBERT CREEK



*Normally extends over a two-year period

TIMING OF SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE STILLAGUAMISH BASIN



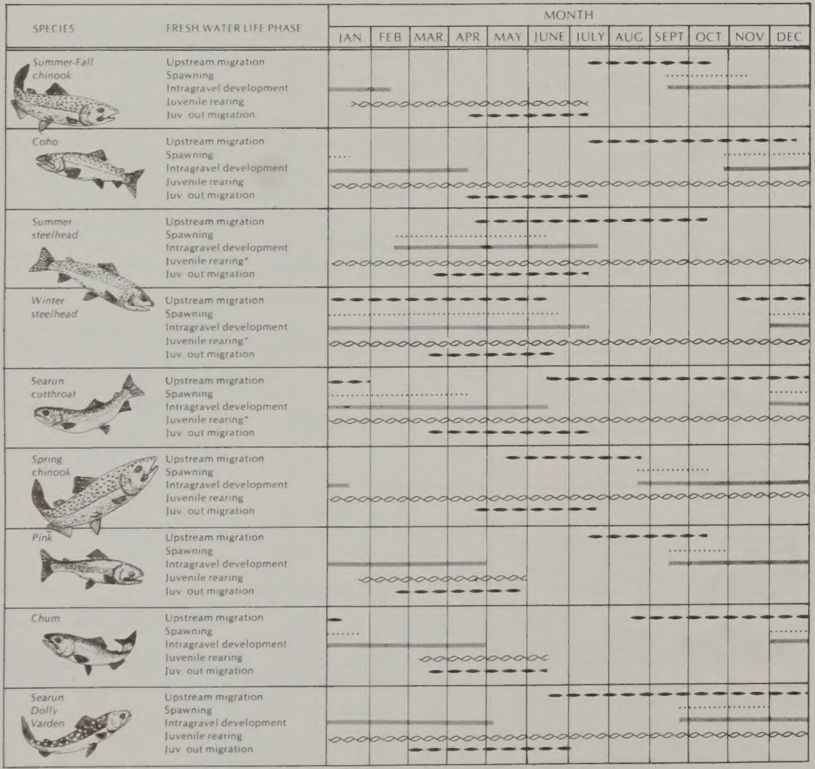
*Normally extends over a two-year period

Sources: Washington Department of Fisheries and U.S. Fish and Wildlife Service 1973; Washington Department of Fisheries 1975; Pacific Northwest River Basins Committee 1970.

Figure 2.1-15

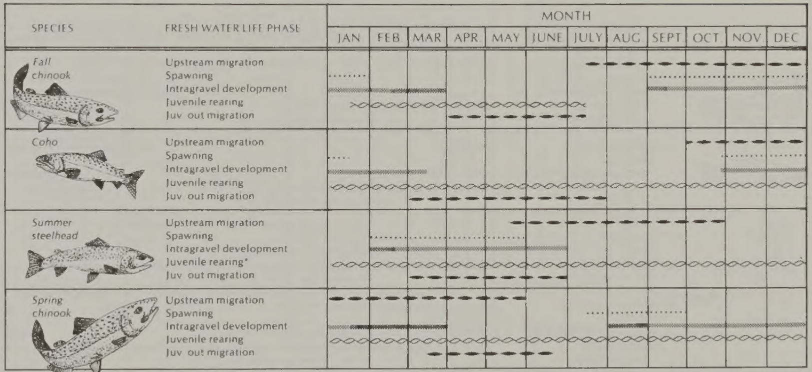
FRESH WATER LIFE HISTORY PHASES OF SALMON AND SEARUN TROUT

TIMING OF SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE SNOHOMISH BASIN



*Normally extends over a two-year period

TIMING OF SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE YAKIMA RIVER



*Normally extends over a two-year period

cold or warm water fishes. Most of the small streams along the corridor are tributary to large streams which support substantial fishery resources.

There are no known endangered or threatened fish species along the proposed corridor according to the list published by the U.S. Fish and Wildlife Service. This list was published in accordance with Public Law 93-205, The Endangered Species Act of 1973.

Insects also play an important role in the freshwater environment. Mayflies, stoneflies, and caddisflies are of major concern. Since young salmon and trout are primarily insect feeders, abundant healthy populations of fishes depend heavily on a good supply of aquatic insects. High quality and sediment-free water are two of the requirements for maintaining these healthy insect populations.

Tables 2.1-64 and 2.1-65 and figures 2.1-15 and 2.1-16 identify the fisheries resources along the proposed corridor.

MARINE RESOURCES

Physical Component

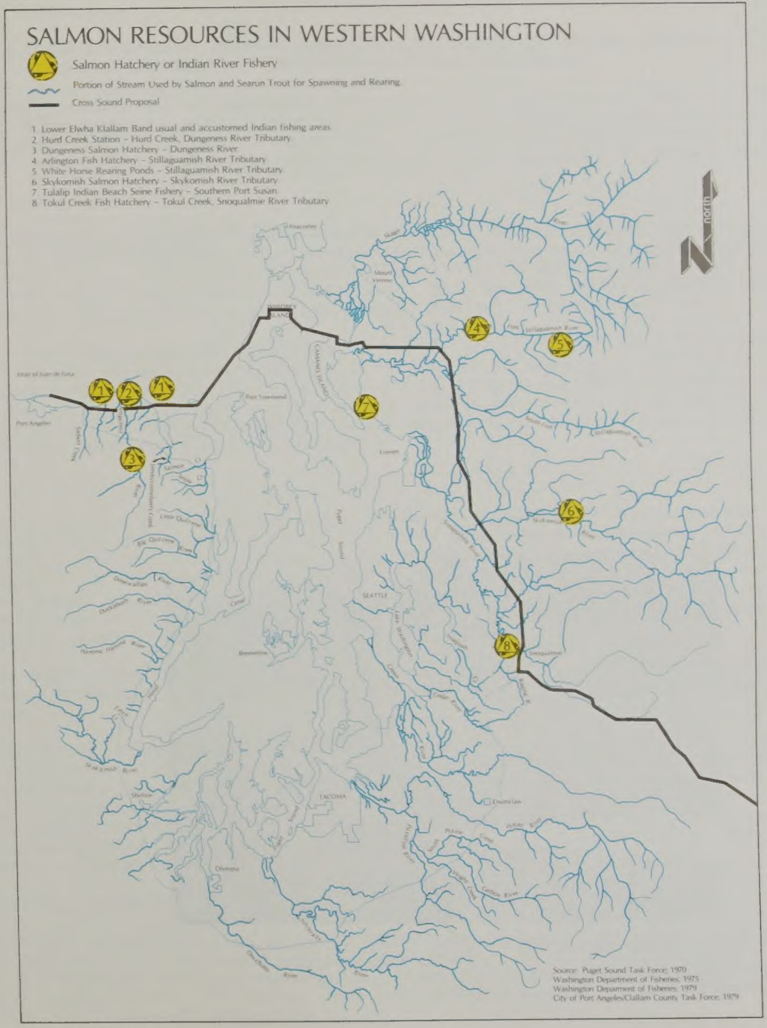
Oceanographic Conditions

From east of Dungeness Bay, the first marine segment of the proposed pipeline route would be in the Strait of Juan de Fuca from Port Williams to Point Partridge. Physical and chemical oceanographic properties along this 18-mile segment are similar to waters offshore of Port Angeles harbor and Dungeness Bay. Bordering this segment the proposed submarine pipeline east of Dungeness Spit are Sequim Bay, Protection Island, Discovery Bay, and Admiralty Inlet. Maximum water depths in the corridor are 366 feet near Diamond Point, and 420 feet near McCurdy Point. Significant wave height near Point Partridge is predicted to be 5 feet during the summer and 4.9 to 5.5 feet during the winter (U.S. Army Corps of Engineers 1977; Fisheries and Environment Canada 1978). Extreme wave heights can reach 15 feet. Tidal heights off Point Partridge are 4.5 feet mean range and 7.7 diurnal range. Average tidal velocities are 0.4 knot on the flood and 2.1 knots on the ebb (U.S. Department of Commerce NOAA 1979a). Subtidal sediments in the corridor are muddy-sand off Port Williams and between Protection Island and Discovery Bay, sand and gravel mix north of McCurdy Point, and sand, gravel, and gravelly-sand off Point Partridge.

The second marine segment of the proposed pipeline would be from Polnell Point on Whidbey Island to Point Brown on Camano Island a distance of about 3 miles. This pipeline segment lies roughly between Skagit Bay and Saratoga Passage and has a maximum water depth of 78 feet. Sediments in this segment consist of sand and gravel off Palnell Point, sandy-mud and muddy-sand in midchannel, and sand off Brown Point (Roberts 1978). Physical and chemical oceanographic properties along the submarine pipeline route are similar to waters in Skagit Bay and Saratoga Passage. The water replacement time in the Whidbey basin is about 40 months. The long flushing time is a result of the large basin volume and the low net seaward flow from the basin to the sea (Vagners and Mar 1972).

Sequim Bay

Sequim Bay is a narrow inlet about 6 miles southeast of Dungeness Spit. The bay extends about 3 miles inland south-southeasterly. Travis Spit extends .5 miles



SALMON RESOURCES IN WESTERN WASHINGTON

Salmon Hatchery or Indian River Fishery
Portion of Stream Used by Salmon and Searun Trout for Spawning and Rearing
Cross Sound Proposal

1. Lower Elwha Klallam Band usual and accustomed Indian fishing areas
2. Hurd Creek Station - Hurd Creek, Dungeness River Tributary
3. Dungeness Salmon Hatchery - Dungeness River
4. Arlington Fish Hatchery - Stillaguamish River Tributary
5. White Horse Rearing Ponds - Stillaguamish River Tributary
6. Skykomish Salmon Hatchery - Skykomish River Tributary
7. Tulalip Indian Beach Seine Fishery - Southern Port Susan
8. Tokul Creek Fish Hatchery - Tokul Creek, Snoqualmie River Tributary

Source: Puget Sound Task Force; 1970
Washington Department of Fisheries; 1975
Washington Department of Fisheries; 1979
City of Port Angeles/Clallam County Task Force; 1979

Figure 2.1-16

TABLE 2.1-65 PIPELINE CROSSING LOCATIONS ON SELECTED WASHINGTON STREAMS AND AFFECTED HABITATS, HATCHERIES, AND FISHERIES

Name Stream	Pipe-line Mile1/	Miles of Spawning Habitat2/	Signifi-cant Spawning Habitat3/	River Mile Crossing Locations4/	Name and location of Hatchery Facility5/	Indian Fishery6/
Siebert Creek	1	8	--	2		Lower Elwha Klallam Band.
Dungeness River	7	36	0-16	4	Dungeness Hatchery 4 miles upstream from crossing. Hurd Creek Station on Hurd Creek (tributary to Dungeness River 1 mile downstream from crossing).	Lower Elwha Klallam Band.
Pilchuck Creek	64	8	--	2		--
Armstrong Creek	68	5	--	2	--	--
North Fork Stillaguamish River	69	41	0-34	1	Arlington Fish Hatchery 10 miles upstream from crossing. Whitehorse Rearing Ponds 25 miles upstream from crossing.	Tulalip Indian Beach Seine Fishery in Port Susan. Fish catches include Stillaguamish and Snohomish River fish.
South Fork Stillaguamish River	70	36	0-45	1	--	--
Little Pilchuck Creek	83,84	10	--	2,4	--	--
Pilchuck River	86	80	0-30	7	--	--
Skykomish River	97	50	0-27	2	Skykomish Salmon Hatchery 16 miles upstream from crossing.	--
Cherry Creek	105	9	--	3	--	--
Harris Creek	108	7	--	4	--	--
Tolt River	111	9	0-8	5	--	--
Griffin Creek	113	7	--	5	--	--
Tokul Creek	120	2	0-2	2	Tokul Creek Fish Hatchery 1 mile downstream from crossing.	--
Snoqualmie River	123	98	20-18	41	--	--
South Fork Snoqualmie River	134		--	16	--	--

1/ Pipeline mile where crossing would occur. 2/ Approximate number of miles of spawning and rearing habitat for anadromous salmon and trout on stream mainstem. Includes areas both upstream and downstream from proposed pipeline crossing. (Puget Sound Task Force 1970; Catalog of Washington Stream 1975.) 3/ Location of significant spawning areas for anadromous and resident salmon and trout by river mile. (Puget Sound Task Force 1970.) 4/ Approximate location of proposed pipeline crossing by river mile from the mouth. 5/ Name and location of hatchery. 6/ Name and location of Indian Fishery. Additional Indian fisheries may occur on other streams.

NOTE: For additional information see Figure 2.1-15.

The Columbia River is a major migration corridor for thousands of salmon annually and also serves as a source for extensive agricultural irrigation downstream. A marina is located at center-right of photo. Crossing would occur near center of photo.

across the bay mouth from the eastern shore. Gibson Spits extends southeasterly on the western shore. Water depth at the entrance is 21 feet. Located at the head of the bay are salt marsh and mud flats. At Pitship Point and in the lagoon behind Gibson Spit are large mud flats. Wave heights at Pitship Point have been predicted from wind data recorded at Port Angeles and Whidbey Island. Table 2.1-66 gives the predictions.

Table 2.1-66 PREDICTED SIGNIFICANT WAVE HEIGHTS AT PITSHIP POINT

Direction	Wave Height (feet)
NNW	2.8
N	3.6
E	2.5
ESE	3.5
SSE	5.4
S	4.8

Source: U.S. Army Corps of Engineers 1977

In the bay the mean tidal range is 4.8 feet and the diurnal range is 7.9 feet (U.S. Department of Commerce NOAA 1979b). Water exchange with Strait water through the relatively small, shallow entrance accelerates the bay tidal currents. Maximum currents, reported at Pitship Point are generally 0.4 knots on flood and ebb tides (U.S. Army Corps of Engineers 1977). General current patterns on flood and ebb are depicted in figure 2.1-17 and 2.1-18. Flushing of the Bay water varies seasonally. On flood tide, less saline water appears to enter the bay in the form of a trough. An estimated 30 percent of incoming Strait water on the flood was not in the bay during the preceeding tidal cycle; thus, the exchange rate for complete flushing would be 2.3 tidal cycles. To exchange waters throughout the bay to a depth of 16 feet would require approximately 10 days, and to exchange water to 50 feet would require about 45 days. Complete flushing of the bay would take several years (U. S. Army Corps of Engineers 1977a).

Discovery Bay

Discovery Bay is located about 5 miles east of Sequim Bay. It is about 6 miles in length and is fed by several small creeks. The width at the entrance, between Diamond Point and Cape George, is about 1 mile. Most of the bay is deeper than 60 feet and at the head are salt marsh and mud flats.

Significant wave heights in Discovery Bay are probably similar to the predicted heights for Sequim Bay. The mean tidal range is 4.8 feet and the diurnal range is 7.9 feet. Observations indicate that tidal currents are weak with directions variable for the greater part of the tidal cycle. A maximum flood velocity of 1 knot has been observed in a southerly direction (U.S. Department of Commerce NOAA 1979b).

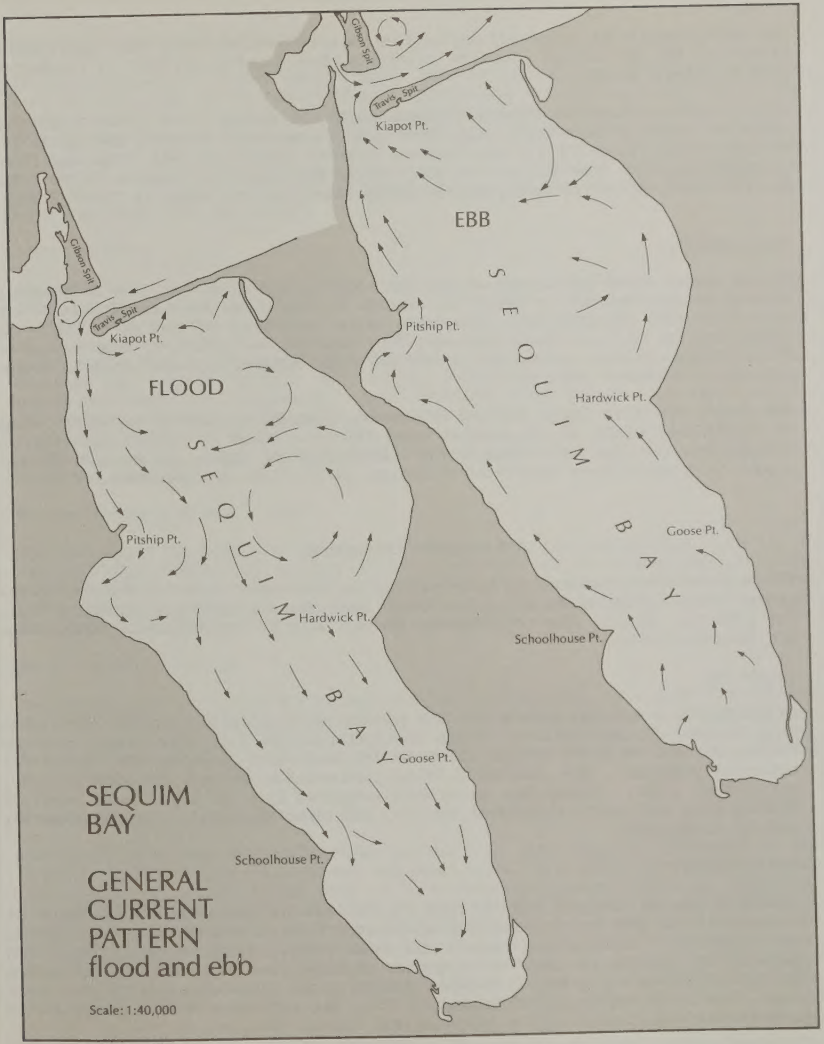


Figure 2.1-17 Figure 2.1-18

Protection Island

Protection Island is a small, triangular shaped island, 1.5 nautical miles north o the entrance to Discovery Bay. North of the island is Dallas Bank.

No tidal range data are available near Protection Island; however, tidal currents have average maximum velocities of 0.3 knots during flood and 1.0 knots during ebb. At about 3 miles northwest of Violet Point, average maximum tidal currents are 0.6 knots during flood true and 1.0 knots during ebb (U.S. Department of Commerce 1979).

Admiralty Inlet

Admiralty Inlet is about 5 miles east of Discovery Bay and connects the Strait of Juan de Fuca with southern Puget Sound and Hood Canal. The inlet entrance is approximately 2.5 miles wide and has a threshold sill depth of 237 feet. The inlet winds south-southwest and is about 2.5 miles wide. The narrowest point is about 2 miles from Bush Point to Nodule Point (Oceanographic Institute of Washington 1977).

Off Port Townsend the mean tidal range is 5.2 feet and the diurnal range is 8.4 feet. The current velocities are too weak and variable to be predicted. Off Bush Point, the mean tidal range is 5.6 feet and the diurnal range is 8.8 feet. Average maximum flood current is 1.6 knots and the average maximum ebb current is 2.6 knots (U.S. Department of Commerce NOAA 1979a). The surface tidal currents during flood in Admiralty Inlet are shown in figure 2.1-19.

Skagit Bay

Skagit Bay is a shallow embayment bound on the west by Whidbey Island, on the east by the mainland, on the north by Skagit and Kiket Islands, and on the south by Camano Island. The bay provides access to Similk Bay, Deception Passage, and Saratoga Passage. On the eastern shoreline are extensive mud flats, a river delta, and a salt marsh, through which the Skagit River enters the bay. At low tide the mud flats are exposed for 1 to 1.5 miles bayward. The channel in the bay lies just east of Whidbey Island and varies in depth from 38 to 144 feet.

The Skagit River strongly influences the Bay. The waters are composed of a relatively freshwater upper layer and of deeper, more saline ocean water (Collias et al. 1974).

Maximum wave heights expected in the Bay would be less than 5 feet during the winter and less than 2 feet from spring to early fall (Vagners and Mar 1972). Tides at Hope Island have a mean range of 6.9 feet and diurnal range of 10.5 feet. Maximum average tidal currents are 2.3 knots on flood and 2.0 knots on ebb. Farther south in the bay the maximum average tidal currents are 1.8 knots on flood and 1.4 knots on ebb. Surface currents during flood tide are complex and are characterized by numerous eddies, as shown in figure 2.1-19.

Saratoga Passage

Saratoga Passage winds 21 miles south-southeast and is bordered on the north and west by Whidbey Island and on the east by Camano Island. The Passage adjoins Skagit Bay on the northwest and Possession Sound and Port Susan on the south. Along the Passage are Crescent Harbor, Oak Harbor, Penn Cove, and Holmes Harbor. Axial water depths vary from 120 feet off Rocky Point to 600 feet at the entrance.

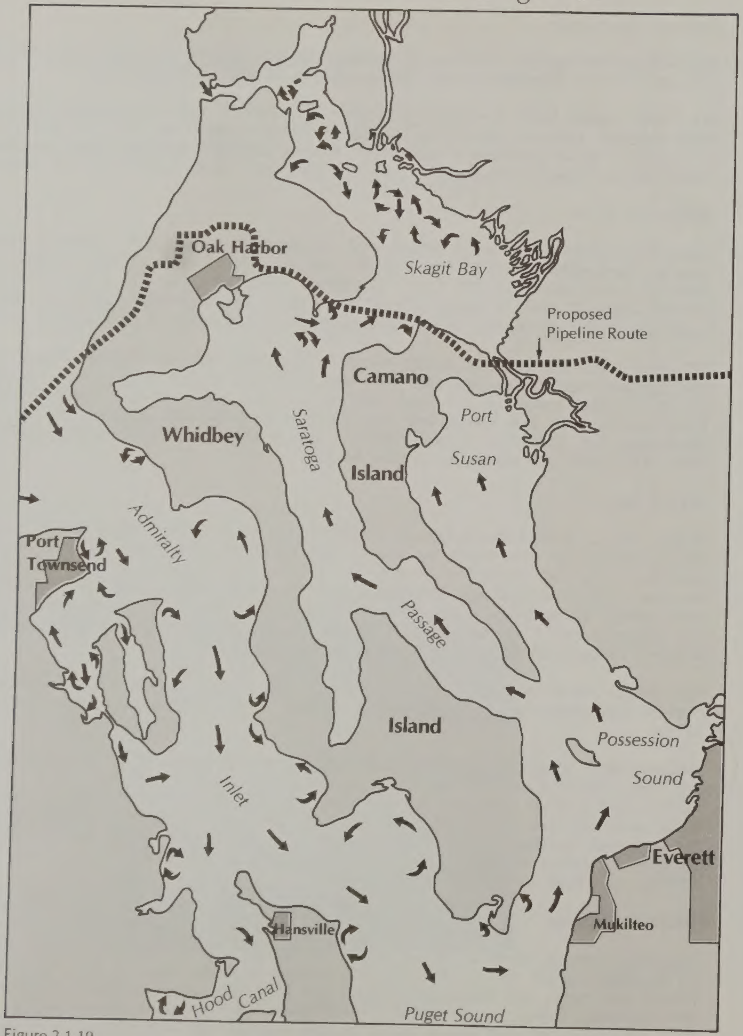

Surface Tidal Currents During Flood

Figure 2.1-19

The waters consist of a low salinity surface layer, a high salinity deep layer, and a mixture of the two waters. The low salinity surface layer is a result of freshwater from the Skagit River.

Wave heights expected in Saratoga Passage would not exceed 5 feet from October to March and would be less than 2 feet from April to September (Vagners and Mar 1972). The mean tidal range is 7.8 feet and the diurnal range 11.5 feet. Maximum flood currents can vary from 0.3 to 0.9 knots (U.S. Department of Commerce 1973). The general flood surface current patterns during flood tide are shown in figure 2.1-19.

Water Quality

Marine waters along the submarine pipeline route in the Strait of Juan de Fuca are classified extraordinary or Class AA. Waters in Sequim Bay and Admiralty Inlet are also classified extraordinary (Washington State Department of Ecology 1977a). No classification has been given Discovery Bay; however, evaluation of mean values of measured water quality parameters in the bay would suggest that the water is extraordinary (EPA STORET 1970, 1978).

The marine waters in Skagit Bay and in Saratoga Passage, as well as the water bodies in the Whidbey Basin, are classified as excellent or Class A. This classification results from the slow basin flushing rate (40 months) and industrial and agricultural inputs (Washington State Department of Ecology 1977). (See Map Addendum).

Biological Components

The proposed route from east of Dungeness Bay would traverse areas of high biological productivity. Eight areas along this route have been identified as locations where the potential impacts from the proposed project will be concentrated. These areas are described below.

Sequim Bay

Sequim Bay is a critical habitat for the Pacific herring and the capelin (Washington Department of Ecology 1977b). Salmon and cutthroat are regularly caught here and Pacific oysters are grown on tidal flats in the south bay. Subtidal and inter-tidal clams are abundant. The area has critical habitats for mallard and pintail ducks, and western grebe. Sequim Bay, along with Dungeness Spit and Bay, is an important feeding area for brant, rhinoceros auklets, and other waterfowl. Canada geese may nest in these areas.

Discovery Bay

Discovery Bay is critical habitat for Pacific herring (Washington Department of Ecology 1977b). The bay is important to demersal fish as well as salmon, cutthroat, and steelhead. Goodwin and Goodwin and Sawl (1978) record major hardshell and geoduck clam beds in the bay. Four species of birds have important habitat in the bay including western grebe, rhinoceros auklet, great blue heron and northern bald eagle (Washington Department of Ecology 1977b). The rhinoceros auklet colony is the largest south of Alaska. Osprey have critical habitat here.

Protection Island and Dallas Bank

Protection Island is located about 2 miles from the entrance of Discovery Bay; Dallas Bank is just north of this small island. The island is critical habitat for rhinoceros auklet, black oyster catcher, pigeon guillemot, glaucous winged gull and pelagic cormorant. It is an important habitat for the harlequin duck. Because it is a haul-out area for harbor seals, the eastern end of Protection Island has been designated a critical habitat (Washington Department of Ecology 1977b). Dallas Bank supports a significant kelp bed, a major hard shell clam bed (Goodwin 1978), and bottom-dwelling fish and salmon.

Admiralty Inlet

Admiralty Inlet connects Hood Canal, Puget Sound, and the Strait of Juan de Fuca. This discussion will be limited to the upper reaches of Admiralty Inlet. Goodwin (1978) lists six major hardshell clam beds, and estimates the size of the beds at 17 million pounds of butter clams alone. Major geoduck beds and crab populations occur here. The Washington Department of Ecology (1977b) lists critical habitats for Pacific halibut, surf smelt, Pacific herring, northern bald eagle, pigeon guillemot, and canvasback. Upper Admiralty Inlet provides important habitat for Barrows goldeneye, bufflehead, white-winged rioter, surf scoter, surfbird, black turnstone, rhinoceros auklet, and old squaw. River otters are found south of Port Townsend. Large numbers of bottom-dwelling and anadramous fish such as salmon and steelhead occur here.

Northwest Shore, Whidbey Island

The Washington Department of Ecology (1976b) does not list any critical habitats on the northwest portion of Whidbey Island. Valuable marine communities are present, however. Large kelp beds contribute to the population of bottom dwelling fish. Salmon are abundant. Goodwin (1978) lists a major geoduck clam bed north of Partridge Point with an estimated 2.6 million clams present.

Smith and Minor Islands

Smith and Minor Islands are within the Smith Island National Wildlife Refuge. Sizeable kelp beds support large bottom dwelling fish populations. The Washington Department of Ecology (1977b) lists Minor Island as a critical habitat for harbor seals and the glaucous winged gull. Smith Island is a critical habitat for the black oystercatcher, rhinoceros auklet, and pigeon guillemot.

Skagit Bay

Hardshell clam beds were identified by the U.S. Army Corps of Engineers in the eastern portion of the bay. Goodwin and Shawl (1978) list other hard shell clam beds in the western part of the bay where it joins Saratoga Passage. There are major soft shell clam beds and Goodwin and Jones (1976) estimated 12.8 million pounds in Skagit Bay. Crabs are abundant and are commercially harvested. Bottom-dwelling fish are abundant throughout the bay as well as pink, chum, chinook, coho, and sockeye salmon. Steelhead are numerous and the Washington Department of Ecology (1977b) has listed the western part of Skagit Bay as critical habitat for steelhead. Critical habitats are listed for American shad and surf smelt. Pacific herring spawn here. Found along the eastern part of the Bay are important habitats for dunlin, long billed dowitcher, western sandpiper and bald eagle (Washington Department of Ecology 1977b). Critical habitats are listed for whistling swan, snow goose, mallard, and American widgeon. River otters occur in the Skagit River (NOAA Technical Memorandum 1979).

Saratoga Passage

Goodwin (1978) identifies a major geoduck clam bed at the southern end of Saratoga Passage. Pacific oyster culture and spawning areas occur in Holmes Harbor and Penn Cove. Intertidal and subtidal hardshell clams are found along most of the shoreline and shrimp are abundant over the southern two-thirds of the passage. Crabs are predominantly found in northern Saratoga Passage where it joins Skagit Bay. Salmon and bottom-dwelling fish are abundant, and herring spawn in the Holmes Harbor area. Critical habitats have been identified for surf smelt, mallard ducks, canvasback, and northern bald eagle. For eight other bird species this is classified as important habitat (Washington Department of Ecology 1977).

Threatened and Endangered Species

For a discussion of endangered marine mammals see section 2.1 Marine Resources. Bald eagle sites can be found throughout the area. (See section 2.1 Terrestrial Wildlife.)

TERRESTRIAL VEGETATION

Washington

The Olympic Peninsula, including Green Point and the pipeline corridor to Sequim Bay (pipeline mile 0-30) is within the cedar-hemlock/Douglas-fir forest ecoregion as shown in the Map Addendum.

This ecoregion is famous for the size and productivity of its timber. Although western hemlock and western red cedar would normally predominate in mature stands, widespread logging has led to complete dominance of large areas by Douglas-fir.

The corridor to Sequim Bay would pass through patches of mixed forest of Douglas-fir, western red cedar, and red alder with an understory of alder, salmonberry, salal, Oregon grape, and juneberry. The bulk of the Dungeness promontory, however, is crop or pasture.

The Willamette-Puget forest ecoregion includes the corridor from Whidbey Island to North Bend in King County (pipeline mile 30 to 126). Forests of this region differ from cedar-hemlock/Douglas-fir forests chiefly in having a significant number of pines. Roughly one-third of the right-of-way in this ecoregion would cross agricultural land.

The Cascades include the silver-fir/Douglas-fir forest ecoregion (mile 126 to 180; see Map Addendum), crossed by the corridor between North Bend and the Columbia River. Forests of Douglas-fir and western hemlock on low western slopes of the Cascades give way at higher elevations to forests of silver fir, hemlock, and Douglas-fir. The understory in these stands is dominated by evergreen shrubs. Moss cover is frequently extensive in moist sites. On the drier eastern Cascade slopes of this ecoregion, Ponderosa pine becomes increasingly more common at middle elevations and below. The pipeline route approaching the foothills of Kittitas Valley and the portion through lower Wenatchee mountains (pipeline mile 200 to 215) would cross open stands of pine with bunchgrasses and scattered shrubs undercover.

Most of the corridor through this ecoregion would parallel existing rights-of-way with a cover of conifer and alder saplings, grasses and bracken fern.

The arid sagebrush-wheatgrass ecoregion of central Columbia Basin would be crossed by the pipeline between pipeline mile 10 and 312 (approximately). Big sagebrush and bluebunch/wheatgrass dominate the vegetation. Annual cheatgrass and Sandberg's bluegrass are common associates and a coating of crust-forming lichens and moss covers much of the soil surface. Native vegetation has been radically altered by agriculture and grazing over much of the pipeline route. Roughly 40 percent of this route segment crosses cropland, mostly dryland wheat fields (NTPC 1979). Bunchgrass in large areas of the remaining range have been replaced by cheatgrass.

Palouse Grassland (see Map Addendum) would be crossed between pipeline mile 312 and 360. Formerly a bunchgrass prairie dominated by bluebunch wheatgrass, Idaho fescue, snowberry, rose, and hawthorn, it is now mostly farmed for wheat.

Idaho

The corridor traverses the Douglas-fir forest ecoregion of the moist Columbian forest province between pipeline mile 360 and 385. Most of the route between pipeline mile 360 and 415 is located on low and middle elevations where Ponderosa pine habitat types are most common (Idaho Park Board 1973).

Ponderosa pine associations in this area vary considerably in composition according to slope, exposure, soil depth, and elevation. Common associates are Douglas-fir, Idaho fescue, bluebunch wheatgrass, snowberry, and bitterbrush. Pine stands are often open and park-like; in the western portion of this pipeline segment, savannahs (less than 25 percent tree cover) may be crossed. Stands of deciduous trees, usually dominated by cottonwoods and/or willow, occur along rivers and streams. About half the land crossed in Benewah County is cropland.

Montana

The cedar-hemlock/Douglas-fir ecoregion of the northern Rockies is crossed by the proposed corridor between pipeline mile 385 and 535. This includes about 55 miles of corridor across the Bitteroot Range in Idaho. Western hemlock, western red cedar, grand fir, Douglas-fir, western white pine, western larch and Ponderosa pine are the most common forest trees in the low to medium elevations traversed by the corridor. Hemlock and cedar are more common in moist areas west of Thompson Falls, and Ponderosa pine on low, drier sites such as those found in the vicinity of Plains (Pfister, et. al., 1977). Along bottomlands in the moist western portion of this route segment, riparian forests of black cottonwood and paper birch with mixtures of white spruce occur. Black cottonwood-Ponderosa pine riparian woodlands occur along the larger alluvial valleys (Pfister et al. 1977). Associated with both bottomland forest types are low trees and shrubs such as willow, alder, elderberry, hawthorn, and chokecherry. Most of the riparian forests are in various stages of succession following floods or disturbance by man.

The next ecoregion crossed by the proposed corridor (pipeline mile 535 to 740) would be Douglas-fir section of the northern Rocky Mountains, a semiarid region climatically distinct from the Douglas-fir section of the Columbian forest province previously described. Ponderosa and lodgepole pines, and western larch (west of the Continental Divide) are the principal tree associates of Douglas-fir (Pfister et al. 1977). Douglas-fir dominates mature stands on most sites in this region, although the pines are frequently dominant in stands recovering from fire. Pinegrass, bluebunch wheatgrass, elk sedge, rough fescue, chokecherry, huckleberry, ninebark, kinnikinnick, snowberry, and twinflower are major herb and shrub associates, occuring in various combinations according to elevation, aspect, and soil quality.

Subalpine fir stands may be encountered at higher elevations near the Continental Divide, while deciduous trees, primarily cottonwood and willow, grow along rivers and streams.

Two ecoregions of the Great Plains shortgrass prairie (Grama-Needle grass-wheatgrass and wheatgrass-Needlegrass sections) include the remainder of the proposed corridor in Montana (pipeline mile 740 to 1,075). Dominant species include blue grama, bluebunch wheatgrass, needle and thread, little bluestem, western wheatgrass, threadleaf sedge, prairie junegrass, and big and silver sagebrush. Scattered stands of Ponderosa pine are found throughout these two ecoregions. Such stands are abundant in east-central Montana (Pfister et al. 1977). Riparian woodlands of black cottonwood, willow, ash, and elm are common along stream courses of the western prairies, becoming increasingly less common eastward.

Approximately 19 percent of the corridor lands in these ecoregions is devoted to agriculture. Most of the remaining native range is in good to excellent condition (USDA 1976).

North Dakota

Western North Dakota, to approximately pipeline mile 1170, is within the wheatgrass-needlegrass prairie ecoregion (see Map Addendum) described above for eastern Montana. Approximately 45 percent of the corridor lands in this part of North Dakota are agricultural.

The wheatgrass-bluestem-needlegrass ecoregion (pipeline mile 1170 to 1390) is crossed by the corridor in Ward, McHenry, Pierce, Bensen, Ramsey, Nelson, and western Grand Forks Counties. Dominant species include prairie junegrass, green needlegrass, little bluestem, western wheatgrass, muhley, side oats grama, sedge, wolfberry, and prairie rose. This prairie vegetation is transitional between short-grass prairie and tall-grass prairie to the east. Approximately 77 percent of the land along the corridor in this ecoregion is cultivated.

Most of North Dakota east of the Missouri River is within the so-called "prairie pothole" region where numerous wetlands, ponds, and small lakes dot the landscape.

The various classes of potholes are:

Class I---Ephemeral Ponds. Common plants are Kentucky bluegrass, Canada anemone, slender wheatgrass, white prairie aster, and other upland species that tolerate short term flooding.

Class II---Temporary Ponds. Primary plants are fowl bluegrass, various sedges, false-aster, and lowland white aster in the potholes with low dissolved-salt concentration; wild barley, cordgrass and lowland white aster in the potholes with slightly brackish water.

Class III--Seasonal Ponds. Moderately coarse grasses and sedges with associated forbs include giant burreed, marsh smartweed, sloughgrass, and tall mannagrass in the fresher potholes.

In the more brackish potholes common plants include whitetop, sloughgrass, marsh smartweed, and common threesquare.

Class IV---Semipermanent Ponds and Lakes. Deep-marsh vegetation commonly occuring in the semipermanent ponds is slender bulrush, cattail, and hardstem and softstem bulrushes in the fresher ponds.

Class V----Permanent Ponds and Lakes. No emergent plants occur in the central portion of these ponds, but western wigeongrass and several other submergent plants are commonly found.

Class VI---Alkali Ponds and Lakes. The central zone is intermittently flooded by alkaline water which alternates with exposed, glistening white, alkali salt flats. Emergent plants do not develop in this zone, but saltwater wigeongrass is often abundant whenever surface water is maintained for a few weeks during the summer.

Class VII--Fen Ponds. Typical vegetation of fens includes a combination of cattail, phragmites, fowl mannagrass, watersedge, hoary willow, and common hemlock.

The number of miles to be traversed by the proposed pipeline through wetland types in not known at this time.

Ponds least subject to extended flooding, particularly those in Class I, are frequently drained for agriculture and many former potholes are now incorporated into fields. The proposed pipeline corridor would cross approximately 8 miles of permanent pothole wetlands, or approximately 3 percent of the pipeline route through the pothole region. This figure is derived from measurements of visible wetland crossings on aerial photograph of the proposed pipeline alignment.

Minnesota

The bluestem prairie ecoregion continues from North Dakota into Minnesota (see Map Addendum) pipeline mile 1390 to 1458. The land that would support prairie vegetation characteristic of this ecoregion is used for agriculture. Riparian woodlands border the Red and Red Lake Rivers in Minnesota. Cottonwood, hackberry, elm, green ash, maple, basswood, and bus oak characterize these woodlands.

The final 33 miles of pipeline corridor (pipeline mile 1458 to 1491) would cross a region of "border prairie" nominally within the spruce-fir forest ecoregion transitional between prairie and eastern forests. This region once consisted of scattered forest stands and tall-grass prairie and is now cultivated. Croplands comprise 90 percent of this segment. The forests (about 3 miles of forest would be crossed) are dominated by aspen, maple, elm, and oak.

Threatened and Endangered Plants

Endangered plants are those perceived to be in danger of extinction. Threatened plants are those rare species likely to become endangered through a significant portion of their range. Known threats to important habitats are often considered when proposing a plant inclusion in in either category. The U.S. Fish & Wildlife Service published a list of vascular plants considered for official designation as endangered in the Federal Register 1976 (reference to this list will be abbreviated 76 FR in table 2.1-67). The Smithsonian Institution published a list proposing endangered and threatened plants in 1978 (abbreviated 78SM). To date, only 20 plants have been officially designated endangered, and 2 have received threatened status. None of these 22 species occur along the proposed pipeline.

The following table includes species proposed by local, state, or federal authorities for endangered or threatened status which could occur within the proposed pipeline corridor, as determined by published reference or personal communication.

North Dakota Pothole Country

U.S. Fish and Wildlife Service

TABLE 2.1-67 ENDANGERED AND THREATENED PLANTS

Common Name	Range	Habitat	Location Near Project	Status 1/	Comments
			WASHINGTON		
Leiberg's milkvetch	Kittitas, Chelan, Douglas Cos.		Near Bush Creek		Restricted range (Denton et al.)
Pauper milkvetch	Kittitas Co.		Near Bush Creek	E76FR E78SM	Both locations near route at pipeline mile 215
	Clelan Co.	Rocky slopes, sagebrush	None known	E76FR E78SM	Known only from Area 10 mi N of route. Could occur on similar habitat in brushy area
branching chaenactis	Wenatchee Mts. Garfield, Yakima, Cos.	Steep, rocky slopes 350-1,525 meters	None known	T78SM	Unlikely along route, usually inaccessible habitats
Kittitas larkspur	S Chelan to N. Yakima Co.	Intermittent streams, springs Sage hills to Pine woodland	Near Swauk Cr, Dry Creek	T78SM	Near pipeline mile 184 to 190. Few populations are known
Upland larkspur	S Chelan, N Kittitas Co.	Many habitats in range	Cle Elum near Sprague	T78SM	Existing population extensive, healthy, recorded near pipeline mile 320
fawnlily	British Columbia S to Oregon	moist woods meadows	None known	T78SM	Could occur in and near Puget Trough
Piper's daisy	Douglas to Benton Co.	Columbia R. plains	Near Crater Siding	T78SM	2 mi S of pipeline mile 23

TABLE 2.1-67 (Continued)

Common Name	Range	Habitat	Location Near Project	Status 1/	Comments
Palouse goldenweed	SE WN, adj. Idaho	Palouse prairie	Near Spangle, Spokane Co.	T78SM	6 mi N pipeline mile 350 habitat reduced by conversion to farms
Ballhead waterleaf	Cent. WN, Columbia gorge area		Bristol Lookout Mt.	E76FR	Vicinity 182 not on 78 SM list
	Whitman Co. adj. ID	Open woods,ah savannah	None known	----	Diminishing habitat, limited range. could occur in E Spokane Co. from Denton et al.
Tweedys Lewisia	S Chelan, N Kittitas Cos.	Rock banks, talus slopes	Snoqualmie Pass	T78SM	2 mi N pipeline mile 145 many collection records
Chelan rockmat	E Chelan Co.	Basaltic cliffs along Creek	None known	E76FR T78SM	Has been found N of Wenatchee only, could occur near Columbia R. Creek crossing but unlikely due to lack of cliffs.
Washington Jacobs-ladder	E WN	moist bottomland 600-900 m	None known	T78SM	Very rare, possibly extinct. Records near Hangman Cr, Spokane Co; Rock Lake, Whitman Co. Could occur along route
	Grant, Kittitas, Yakima Co.	Scabland sage 400-1220 m	None known	E76FR E78SM	Records near Cou-Lee City, Vantage. Could occur near route
Wenatchee valerian	Okonagon to Kittitas Cos., Wenatchee Mts.	Open slopes	None known	T78SM	Could occur along route in E Kittitas Co.

TABLE 2.1-67 (Continued)

Common Name	Range	Habitat	Location Near Project	Status 1/	Comments
Cascades violet	Okonagon Co. to Deschutes Co, OR		None known	T78SM	Rare. Could occur near Cascades route segment
IDAHO					
Constance's bittercress	Clear-water, Idaho Nez Perce Shoshone Co.	Lower elevation red cedar forests	Has been collected at six sites in Shoshone County	E76FR E78SM	Status change to threatened recommended, Idaho Rare Plant Study Group
	Beneuah Co, St. Maries R.	Bluffs	None known	E78SM	Possibly extinct in Idaho. Occurs in MT. Does not appear on 78SM list nor 76FR
MONTANA					
	Missoula Co. Bitteroot Mts.	Probably basaltic bluffs	None known	E78SM	Known from population WNW of Missoula
Phlox	N of Missoula near city	Foothills	Between mile 540 and 555	E76FR E78SM	
	ID,MT, OR, WA	Palouse Prairie, Montana meadows, open forests	None known	E76FR E78SM	Very rare, though widespread. Known from Flathead and Sanders Co. in MT.
	Misssoula Co.		None known	E76FR E78SM	Known only from Lolo Hot Springs, 25 miles SW of rou
NORTH DAKOTA					
There are no federally listed endangered species in North Dakota.					

TABLE 2.1-67 (Continued)

Common Name	Range	Habitat	Location Near Project	Status 1/	Comments
MINNESOTA					
The two Minnesota plants listed as endangered on the 76FR list have never been recorded from the counties crossed by the proposed pipeline, and are unlikely to occur in the project area. Minnesota trout lily (Erythrosium propullans), the state's only known endemic plant, is proposed for endangered status on the 78SM list but occurs only in southeast Minnesota, and would not be affected by the project.					

TABLE 2.1-68

LOCATION OF THREATENED AND ENDANGERED SPECIES—NORTHERN BALD EAGLE AND AMERICAN PEREGRINE FALCON[1]

Species	Total Numbers	Location	Pipeline Mile	Habitat Descriptions and Observations						
				Nest Sites		Wintering Sites		Season of Occurrence	Sightings and Activities	Sources
				Active[2]	Inactive[3]	Resident[4]	Occasional[5]			
Northern Bald Eagle	4	Washington Green Point	0	×		×		Resident and Winter	At least four northern bald eagles roost and feed in the area daily (February 1978). Two adults and three young were frequently observed December-March 1979. An active nest site was blown down and the nest was not rebuilt in 1979	BLM 1979
Northern Bald Eagle	Unknown	Dungeness Bay	10				×	Winter	Feeding occurs around Dungeness Spit and Dungeness Bay. Eagles observed roosting near Jamestown between Dungeness Bay and proposed pipeline route	U.S. Fish and Wildlife Service 1979
American Peregrine Falcon	Unknown	Jamestown and Dungeness Bay	10				×	Winter	Wintering falcons feed and roost in the general area around Jamestown between the proposed pipeline route and Dungeness Bay	U.S. Fish and Wildlife Service 1979
Northern Bald Eagle	Unknown	Whidbey Island	30-45	×				Resident year-round	Active nest in 1975 approximately 1 mile south of proposed pipeline route. Other active nests near Coupeville. Seven eagles observed near Polnell Point during spring of 1979	Grub, 1975
Northern Bald Eagle	Unknown	Keechelus Lake	154-170		×	×		Not identified	No known nests within corridor. Eagles frequently seen in general area between Keechelus and Cle Elum Lakes	U.S. Forest Service 1978
Northern Bald Eagle	10-15	Idaho Coeur d'Alene River	380-425		×	×		Winter	No nest identified. Eagles observed feeding along south shore of Coeur d'Alene Lake as well as Coeur d'Alene River and St. Joe River	Idaho Department of Game 1978
Northern Bald Eagle	4	Montana Clark Fork River	465-482		×	×		Resident	No nests identified but high probability of nest in area. Eagles frequently sighted during breeding season	U.S. Forest Service 1978
American Peregrine Falcon	Unknown	Nine mile Creek	520-530					Unknown	Peregrine falcons sighted along river during breeding season. Potential falcon breeding and wintering area	U.S. Forest Service 1978

LOCATION OF THREATENED AND ENDANGERED SPECIES—NORTHERN BALD EAGLE AND AMERICAN PEREGRINE FALCON[1]

Species	Total Numbers	Location	Pipeline Mile	Habitat Descriptions and Observations						
				Nest Sites		Wintering Sites		Season of Occurrence	Sightings and Activities	Sources
				Active[2]	Inactive[3]	Resident[4]	Occasional[5]			
American Peregrine Falcon	Unknown	Nine mile Creek	510-520			×		Spring	Potential falcon nesting habitat in area. Falcons observed during breeding season. Designated as essential falcon habitat by U.S. Forest Service	U.S. Forest Service 1978
Northern Bald Eagle	Unknown	Nine mile Creek	500-530			×		Unknown	U.S. Forest Service designated area as essential bald eagle winter habitat	U.S. Forest Service 1978
Northern Bald Eagle	10-15	Canyon Ferry Lake	690		×	×		Winter	No known nest within corridor. Eighteen eagles in one observation at roosting area along south shore of lake. Wintering eagles in area from October through March	U.S. Fish and Wildlife Service 1978
Northern Bald Eagle	Unknown	Deep Creek	695-700		×	×		Winter	No known nests within corridor. Fluctuating population in Deep Creek area southeast of Canyon Ferry Lake from October through March	U.S. Fish and Wildlife Service 1978
Northern Bald Eagle	Unknown	Minnesota Clearbrook	1485		×	×		Resident year-round	Two young produced in 1978. Nest active during last 10 years. Tornado recently destroyed nest. Site still potentially viable. Nesting status of attendant eagles unknown.	U.S. Fish and Wildlife Service 1978

Northern bald eagles are classified as threatened in Washington and Minnesota and endangered in Idaho, Montana, and North Dakota. American peregrine falcons are classified as endangered.

[2] Nest occupied and young produced at least once since 1975.

[3] No known nests near corridor; potential nest sites available; observations of eagles in general area.

[4] Frequent observations of eagle populations from September through February.

[5] Occasional observations during winter; occurrence of resident populations unknown.

TERRESTRIAL WILDLIFE

Threatened and Endangered Species

The proposed route would cross ranges of several wildlife species that have been classified by the U.S. Fish and Wildlife Service as either threatened or endangered in accordance with Public Law 93-205, The Endangered Species Act of 1973. In some instances, available data are insufficient to document occurrence within the corridor or to identify specific use area. Most of these data gaps can be filled only be intensive on-site surveys.

Northern bald eagle and American peregrine falcon locations along the proposed pipeline route are identified in table 2.1-68.

Prairie dog towns near Nelson Creek (pipeline mile 970) south of Fort Peck Lake, Montana, provide habitat for and are within the range of the endangered black-footed ferret. No ferret sightings have been reported within the corridor; however, ferrets are seldom seen throughout their range.

Other threatened or endangered species whose range or migratory route would be crossed by the proosed corridor include gray wolf, whooping crane, Arctic peregrine falcon, and northern kit fox. No recent sightings of these species have been reported within the corridor.

Areas of Special Concern

Areas along the proposed route supporting wildlife species that would be particularly susceptible to impacts are included in this section. The areas have been identified by federal, state, and local agencies. Selection criteria included, but was not limited to: 1) areas supporting high densities of a particular species; 2) areas supporting a high diversity of species; 3) areas containing breeding habitat susceptible to damage; 4) areas supporting wildlife susceptible to disturbance during breeding season; and 5) areas containing limited or essential habitat such as wintering and riparian areas. Also, areas were selected for inclusion based on regional and local importance. Additional areas supporting wildlife occur along the proposed route. Only those areas where significant impacts would occur have been addressed. Areas of special concern are identified in table 2.1-69.

The prairie pothole region of North Dakota is important for waterfowl production and merits additional discussion since migratory waterfowl are internationally important. Between the Missouri River and the Red Lake River approximately 250 miles of prairie pothole habitat would be crossed. Approximately 8 miles of permanent potholes would be crossed by the pipeline; however, these may vary seasonally in size. Waterfowl habitat is limited by the availability of water areas suitable for nesting and feeding. The prairie pothole region comprises 10 percent of the total waterfowl breeding area in North America but produces over 50 percent of all the duck crop (BLM Techn Suppl. 6601.5 and Smith, Stoudt, and Gollop 1964). Stewart and Kantrud (1974) found the prairie pothole region to be extremely productive, averaging 44 pairs of breeding waterfowl per square mile.

The U.S. Fish and Wildlife Service (1978) sampled wetlands along 14 miles of the proposed route. The data indicate that a 100-foot wide corridor through 260 miles of the prairie pothole region would contain approximately 337 wetlands totaling 725 acres. Many of these wetlands are controlled by the U.S. Fish and Wildlife Service under one of two programs: 1) easements, whereby landowners retain most of th
property rights and agree not to drain, burn, fill, or level the wetlands; and 2) fe
lands or waterfowl production areas (WPAs), where the U.S. Fish and Wildlife Servic
maintains total ownership and management rights. Table 2.1-70 gives county acreage
in the wetland programs (see Map Addendum).

TABLE 2.1-69 AREAS OF SPECIAL CONCERN

Location	Wildlife	Pipeline Miles
Washington		
Whidbey-Camano Islands	Black bear, mule deer, raptors and blue grouse inhabit the mixed coniferous forest	29-54
Cascade Range	Elk and deer winter range along eastern slopes	154-170
Keechelus Lake to Cle Elum	Osprey nesting along the western shore of Keechelus near the dam on Kachess Lake and near the Cle Elum River crossing of I-90. Elk and deer winter range near Cle Elum	
Colockum Wildlife Recreation Area	Deer and elk prime winter range Antelope and mountain sheep also inhabit the area	212-222
Columbia River-Crescent Bar	Nesting habitat for at least 20 pair of geese	224
Rocky Ford Creek	Riparian vegetation provides habitat for long-billed curlew and upland game birds Waterfowl nesting and migratory areas downstream of Moses Lake	253
Gloyd Seeps	Prime waterfowl habitat	257-268
Sprague Lake	Winter concentrations downstream from river crossing	315-320
Idaho		
Benewah Lake	Winter habitat for whistling swans and geese and up to 20,000 waterfowl Great blue heron rookery of 20-30 nests	384

TABLE 2.1-69 (Continued)

Location	Wildlife	Pipeline Miles
Idaho (Cont.)		
St. Joe River	Second largest concentration of nesting ospreys in the western states at the river mouth	386
Cave Lake	Waterfowl production area Nesting and breeding grounds for as many as 10,000 Canada geese Waterfowl staging area for spring migration route	395
Montana		
Prichard and Prospect Creeks	Elk and deer winter range- 14 beaver dams along Prospect Creek	430-462
Clark Fork River	Elk and deer winter range Big horn sheep habitat: herd of 80 Elk calving on Clark Fork River Island Nesting habitat for duck and up to 68 pair of Canada geese Osprey and raptor nests including prairie falcon	465-473 468-473 470 470 465-482
Siegal Creek	Elk and deer winter habitat	500-505
Ninemile Creek	Owl and raptor habitat Deer and 40-80 elk summer and winter ranges	505-530
Blackfoot River-Garnet Range	Deer and elk summer and winter range Elk calving grounds Abundant grouse habitat	554-605

TABLE 2.1-69 (Continued)

Location	Wildlife	Pipeline Miles
Montana (Cont.)		
Canyon Ferry Lake	State waterfowl management area immediately downstream of Missouri River crossing Nesting habitat for up to 800 Canada geese	690 690
Musselshell River	Elk and deer winter habitat and waterfowl breeding areas along river drainage	740-770
Lake Mason	National Wildlife Refuge downstream of several river crossings	825-830
Flatwillow Creek	Habitat for pheasant and white-tailed deer	839-849
Ft. Peck Lake, South of Charles M. Russell National Wildlife Refuge	Sage-grouse and sharp-tailed grouse strutting and dancing grounds occur near tributary streams	964-976
North Dakota		
Williston, Stanley, Devil's Lake	Sharp-tailed grouse dancing areas near Williston, Stanley, and Devil's Lake	1090-1330
Minot to E. Grand Forks	Miscellaneous prairie pot-holes provide important waterfowl production and staging areas	1207-1410
Minnesota		
Red River to Clearbrook	Sharp-tailed grouse, greater prairie chicken, and pheasant habitat in wooded riparian areas Deer winter habitat in wooded bottomlands	1415-1490

Sources: U.S. Fish and Wildlife Service; U.S. Forest Service; State Departments of Fish and Game

TABLE 2.1-70 U.S. FISH AND WILDLIFE SERVICE WETLANDS WITHIN A 3-MILE CORRIDOR ALONG THE PROPOSED ROUTE IN NORTH DAKOTA (in Acres)

County	Easements	Fee Lands	Total
Mountrail	18,100	220	18,320
Ward	4,040	0	4,040
McHenry	4,800	425	5,225
Pierce	7,480	800	8,280
Benson	16,330	280	16,610
Ramsey	32,950	935	33,885
Nelson	13,520	0	13,520
Grand Forks	840	0	840
Total	98,060	2,660	100,720

Source: U.S. Fish and Wildlife Service 1978

CULTURAL RESOURCES

Cultural resources include buildings, structures, ruins, sites, objects, artifacts, works of art, and natural features that were of importance in human events, and other modifications of the natural environment, such as trails, ditches, special resource procurement areas, or earthworks. These resources consist of physical remains--areas where significant human events occurred even though evidence of the events no longer remains--and the environment immediately surrounding the actual resource. By their nature, cultural resources are fragile, finite, irreplaceable, and nonrenewable.

Cultural resources of both prehistoric and historic times represent unique records of human activity during some time in the past at each particular place they occur. Paleontological resources are also discussed in the cultural resource sections of this Environmental Statement.

Most archaeological sites are difficult to observe, usually buried or covered by vegetation, and not necessarily located in areas that seem to be obvious places for human activity. Most historical resources are not archaeological sites and are therefore easier to observe. However, most of them have not been identified, recorded, and evaluated in terms of historical significance. Therefore, locations of most cultural resource sites in general, and along the corridor proposed for the NTPC pipeline in particular, are not currently known.

Known cultural resource sites along the proposed pipeline corridor have been identified haphazardly or by localized surveys. The cultural resources described here are the known resource base only. It is expected that presently unrecorded cultural resources will be discovered along the proposed pipeline right-of-way . But until more is known, it is not possible to accurately describe the cultural resources which may be damaged or destroyed by the proposed project.

Archaeological Resources

This section is concerned only with prehistoric archaeological sites. Histor archaeological sites are included in the section on Historical Resources.

The areas crossed by the proposed pipeline contain evidence of human groups fro earliest times to the present. Artifacts and bones indicate the presence of hunter of mastodon, mammoth, and giant forms of bison living in some areas as many as 10,00 to 12,000 years ago. As the large mammals became extinct, hunters turned to deer an smaller species of bison. Later archaeological records show increased regional specialization in food usage and associated artifacts . During the final 2,000 year of prehistory, adaptations more familiar to our own experience appeared: salmo fishing; hunting and gathering of wild plants in the mountains and plains; an agriculture in villages along the eastern river valleys.

The accompanying chart (figure 2.1-20) provides brief indications of cultural adaptations that occurred in areas crossed by the proposed pipeline. This corridor, including the underwater portions which would cross Puget Sound, contains evidence of many prehistoric cultural sites. Virtually the entire route has potential fo containing unrecorded archaeological sites which may be related to any or all time periods and cultural adaptations.

The archaeological sites in the accompanying table (2.1-71) are the officially recorded prehistoric cultural resource base potentially affected by the proposed project. It is probable that local residents know the location of sites within and near the corridor not listed here. In many cases the age and cultural affiliation of the sites are not known. This data gap can only be filled by archaeological testing of the sites. These tests determine eligibility for the National Register of Historic Places and site significance. Those sites listed in (or eligible for inclusion in) the latest edition of the National Register (February 6, 1979) and monthly supplements through June 5, 1979, are indicated in table 2.1-71. These sites, and any determined eligible for the Register during of the proposed project, would be protected by federal laws and regulations.

Historical Resources

Historic sites are related to Native Americans described by Euro-American traders, explorers, settlers, and anthropologists, and to early Euro-American activities. These resources include trails and campsites, missions, fur trading posts, townsites, homesteads, logging camps, military posts, mines, railroads and railroad construction camps, and roads used by immigrants, merchants, and the military.

No attempt will be made to provide an historical sketch of the northern tier states. Native Americans were at first affected indirectly by the Euro-American presence on the continent. Trade goods, diseases, and native population movements preceded actual contact due to inter-tribal contacts. Explorers, fur traders, missionaries, miners, farmers, ranchers, scientists, merchants, soldiers, loggers, surveyors, construction workers, and others made their appearance. Their presence is recorded in the sites, properties (archaeological, structural, and terrain modifications), and records which make up the historical cultural resource base. Because they were engaged in mutually dependent and supportive enterprises, many historical sites may have significance to several dimensions of human history in an area.

TABLE 2.1-71 PREHISTORIC ARCHAEOLOGICAL SITES ALONG THE PROPOSED NORTHERN TIER PIPELINE CORRIDOR

County, State	Site Number	Site Name	National Register	Site Type	Location By Pipeline Mile	Within 2-Mile Study Corridor	Outside Study Corridor
Island, WA	45IS43	—	No	Shell Midden	43	X	
Island, WA	45IS42	—	No	Shell Mound	46	X	
Island, WA	45IS41	--	No	Shell Midden	46	X	
Island, WA	45IS40	--	No	Campsite and shell midden	47		X
Island, WA	45IS83	—	No	Shell midden and burial	51	X	
Island, WA	45IS83B	—	No	Shell midden	54	X	
Island, WA	45IS12	—	No	Burials	54	X	
Snohomish, WA	45SN1	—	No	Shell midden	55	X	
Snohomish, WA	45SN2	—	No	Shell midden	55	X	
Snohomish, WA	45SN3	—	No	Shell midden	55	X	
Snohomish, WA	45SN33	--	No	Stratified shell midden	71	X	
Snohomish, WA	45SN24	—	No	Campsite	84	X	
Snohomish, WA	45SN19	—	No	Shell midden	86	X	
Snohomish, WA	45SN18	—	No	Shell midden	86	X	
Snohomish, WA	45SN38	—	No	Campsite and midden	89	X	
Snohomish, WA	45SN48	—	No	Campsite	91	X	
Snohomish, WA	45SN46	—	No	Campsite	91	X	
Snohomish, WA	45SN47	--	No	Campsite	91	X	
Snohomish, WA	45SN13	--	No	Campsite and shell midden	96	X	
Kittitas, WA	45KT91	—	No	Campsite	178	X	
Kittitas, WA	45KT215	Tekison Cave	Yes	Habitation site	218		X
Kittitas, WA	45KT66	—	No	Petroglyph site	222	X	
Kittitas, WA	45KT49	—	No	Campsite	222	X	
Kittitas, WA	45KT84	—	No	Habitation site with house pits	223	X	
Kittitas, WA	45KT85	—	No	Habitation site with house pits	223	X	
Kittitas, WA	45KT31	—	No	Campsite	223	X	
Grant, WA	45GR128	—	No	Campsite	224	X	
Grant, WA	45GR129	—	No	Campsite	224	X	
Grant, WA	45GR142	—	No	Fossil tusks; possibly artifacts	225	X	
Grant, WA	45GR72	—	No	Campsite and burial site	253		X
Lincoln, WA	45LN1?	—	No	Rockshelter and burial site	320	X	
Benewah, ID	10BW30	--	No	Rock structures	380		X
Benewah, ID	10BW10	--	No	Burial mound	384	X	
Kootenai, ID	10KA20	—	No	Habitation--cave site	395	X	
Kootenai, ID	10KA34	—	No	Habitation site	397	X	
Kootenai, ID	20KA43	--	No	Campsite	409	X	
Sanders, MT	24SA1084	—	No	Transient occupation	474	X	
Sanders, MT	24SA1022	—	No	Pictographs	488	X	
Sanders, MT	24SA1114	—	No	Prehistoric trail	488	X	
Sanders, MT	24SA1115	--	No	Occupation	494	X	
Sanders, MT	24SA1116	—	No	Pictographs	496	X	
Sanders, MT	24SA1016	—	No	Occupation	500	X	
Missoula, MT	24MO110	--	No	Occupation	508	X	
Missoula, MT	24MO29	--	No	Occupation	511	X	
Missoula, MT	24MO50	--	No	Activity area	512	X	
Missoula, MT	24MO28	--	No	Occupation	512	X	
Missoula, MT	24MO30	--	No	Occupation	513	X	
Missoula, MT	24MO55	--	No	Lithic quarry	514	X	
Missoula, MT	24MO40	--	No	Lithic quarry	515	X	
Missoula, MT	24MO27	--	No	Lithic quarry	516	X	
Missoula, MT	24MO510	—	No	Occupation	516	X	
Missoula, MT	24MO513	—	No	Occupation	517	X	
Missoula, MT	24MO511	--	No	Occupation	518	X	
Missoula, MT	24MO504	—	No	Occupation	522	X	
Missoula, MT	24MO47	—	No	Activity area	522	X	
Missoula, MT	24MO1093	—	No	Multiple stone structures	548	X	
Missoula, MT	—	—	No	Burials	548	X	
Missoula, MT	24MO25	—	No	Artifact locality	551	X	
Missoula, MT	24MO1071	--	No	Burial	551	X	
Missoula, MT	24MO10	—	No	Occupation	554	X	
Missoula, MT	24MO11	—	No	Occupation	555	X	
Missoula, MT	24MO1003	—	No	Occupation	557	X	
Missoula, MT	24MO16	—	No	Occupation	566	X	
Missoula, MT	24MO1084	—	No	Occupation	566	X	
Missoula, MT	24MO15	--	No	Occupation	566	X	
Missoula, MT	24MO14	—	No	Occupation	566	X	
Granite, MT	24GN149	—	No	Site type not known	584	X	
Granite, MT	24GN105	Three Springs Quarry	No	Lithic quarry	594	X	
Granite, MT	24GN106	Wild Horse Parks	No	Occupation	595	X	
Granite, MT	24PW102	--	No	Site type not known	595	X	
Granite, MT	24PW316	—	No	Occupation	600	X	
Powell, MT	24PW308		No	Occupation	600	X	
Powell, MT	24PW317	--	No	Occupation	600	X	
Powell, MT	24PW301	--	No	Occupation	600	X	
Powell, MT	24PW315	—	No	Occupation and burial	601	X	
Powell, MT	24PW1064	Ostler's Corrals	No	Occupation	604	X	
Powell, MT	24PW98	—	No	Campsite	605	X	
Powell, MT	24PW1006	--	No	Occupation	612	X	
Powell, MT	24PW1008	—	No	Work station and temporary campsite	614	X	
Powell, MT	24PW1075	—	No	Campsite	614	X	
Powell, MT	24PW1020	—	No	Occupation	615	X	
Powell, MT	24PW1010	--	No	Occupation	615	X	
Powell, MT	24PW1035	--	No	Temporary chipping and lookout station	616	X	
Powell, MT	24PW1011	Wooden Bridge site	No	Occupation	616	X	
Powell, MT	24PW1033	—	No	Temporary chipping station	616	X	
Powell, MT	24PW1038	—	No	Occupation	616	X	
Powell, MT	24PW1032	—	No	Occupation	617	X	
Powell, MT	24PW1040	—	No	Extensive lithic scatter	617	X	
Powell, MT	24PW1030	Finn Creek site	No	Campsite	618	X	
Powell, MT	24PW1029	—	No	Chipping station	618	X	
Powell, MT	24PW1042	—	No	Occupation	619	X	
Powell, MT	24PW1044	—	No	Occupation	621	X	
Powell, MT	24PW1043	—	No	Occupation	622	X	
Powell, MT	24PW1045	—	No	Occupation	623	X	
Powell, MT	24PW1018	—	No	Chipping station	628	X	

TABLE 2.1-71 PREHISTORIC ARCHAEOLOGICAL SITES ALONG THE PROPOSED NORTHERN TIER PIPELINE CORRIDOR

County, State	Site Number	Site Name	National Register	Site Type	Location By Pipeline Mile	Within 2-Mile Study Corridor	Outside Study Corridor
Powell, MT	24PW1016	Hanley site	No	Occupation	628	X	
Powell, MT	24PW1015	--	No	Campsite	628	X	
Powell, MT	24PW1021	Blackfoot City I	No	Occupation	628	X	
Lewis and Clark, MT	24LC215	--	No	Occupation	639	X	
Lewis and Clark, MT	24LC246	--	No	Occupation	640	X	
Lewis and Clark, MT	24LC8	—	No	Campsite with tipi rings	669	X	
Broadwater, MT	24BW32	—	No	Tipi rings	670	X	
Broadwater, MT	24BW36	--	No	Tipi rings	673	X	
Broadwater, MT	24BW1002	--	No	Tipi rings	673	X	
Broadwater, MT	24BW48	--	No	Occupation	678	X	
Broadwater, MT	24BW71	Kimber Gulch site	No	Occupation and tipi rings	681	X	
Broadwater, MT	24BW1010	--	No	Tipi rings	682	X	
Broadwater, MT	24BW1011	—	No	Vision quest and rock structures	682	X	
Broadwater, MT	24BW65	Dry Creek site	No	Occupation	701	X	
Meagher, MT	24ME1001	Horse Butte tipi rings	No	Occupation	727	X	
Meagher, MT	24ME653	Horse Butte site	No	Occupation	727	X	
Meagher, MT	24ME652	Vinton site	No	Occupation and tipi rings	728	X	
Meagher, MT	24ME143	--	No	Tipi rings	734	X	
Meagher, MT	24ME554	Lennep rock mounds	No	Rock structures	742	X	
Meagher, MT	24ME404	Martinsdale Ranger Station, buffalo kill site	No	Bison kill site	756	X	
Musselshell, MT	24ML407	--	No	Tipi rings	831	X	
Musselshell, MT	24ML406	—	No	Tipi rings	833	X	
Petroleum, MT	24PT54	--	No	Chipping station and hearths	870	X	
McCone, MT	24MC60	--	No	Chipping station	959	X	
McCone, MT	24MC59	--	No	Chipping station	960	X	
McCone, MT	24MC61	--	No	Kill site	960	X	
McCone, MT	24MC5	—	No	Campsite and rockshelter	968	X	
Richland, MT	24RL505	--	No	Rock structures	1023	X	
Richland, MT	--	--	No	Archaeological Site; type not known	1056	X	
Richland, MT	24RL514	--	No	Rock structures	1059	X	
Richland, MT	24RL1006	--	No	Burial	1060	X	
Richland, MT	--	--	No	Archaeological Site; type not known	1062	X	
Richland, MT	24RL8	--	No	Chipping station	1062	X	
Williams, ND	—	--	No	Burial mound	1075	X	
Williams, ND	--	--	No	Possible bison kill	1075	X	
Williams, ND	—	—	No	Campsite	1076	X	
Williams, ND	—	—	No	Campsite	1094	X	
Williams, ND	—	—	No	Campsite	1098	X	
Williams, ND	—	—	No	Campsite	1098	X	
Williams, ND	—	—	No	Campsite	1111	X	
Williams, ND	—	—	No	Campsite	1128	X	
Mountrail, ND	--	--	No	Occupation	1136	X	
Mountrail, ND	—	—	No	Occupation	1138	X	
Mountrail, ND	—	—	No	Occupation	1139	X	
Mountrail, ND	—	—	No	Occupation	1139	X	
Mountrail, ND	—	—	No	Occupation	1139	X	
Mountrail, ND	—	—	No	Occupation	1139	X	
Mountrail, ND	—	—	No	Occupation	1139	X	
Mountrail, ND	—	—	No	Occupation	1140	X	
Mountrail, ND	—	—	No	Occupation	1140	X	
Mountrail, ND	—	—	No	Occupation	1141	X	
Mountrail, ND	—	—	No	Occupation	1141	X	
Mountrail, ND	—	—	No	Occupation	1142	X	
Mountrail, ND	—	—	No	Occupation	1143	X	
Mountrail, ND	—	—	No	Occupation	1143	X	
Mountrail, ND	--	--	No	Occupation	1145	X	
Mountrail, ND	--	--	No	Occupation	1146	X	
Mountrail, ND	--	—	No	Occupation	1147	X	
Mountrail, ND	—	—	No	Occupation	1148	X	
Mountrail, ND	—	—	No	Occupation	1148	X	
Mountrail, ND	—	—	No	Occupation	1149	X	
Mountrail, ND	—	—	No	Occupation	1150	X	
Mountrail, ND	—	—	No	Occupation	1151	X	
Mountrail, ND	--	—	No	Occupation	1157	X	
Mountrail, ND	--	—	No	Occupation	1160	X	
Mountrail, ND	—	—	No	Occupation	1160	X	
Mountrail, ND	—	—	No	Occupation	1160	X	
Mountrail, ND	—	—	No	Occupation	1161	X	
Mountrail, ND	—	—	No	Occupation	1162	X	
Mountrail, ND	—	—	No	Occupation	1162	X	
Mountrail, ND	—	—	No	Occupation	1162	X	
Mountrail, ND	—	—	No	Occupation	1162	X	
Mountrail, ND	—	—	No	Occupation	1163	X	
Mountrail, ND	—	—	No	Occupation	1164	X	
Mountrail, ND	—	—	No	Occupation	1165	X	
Mountrail, ND	—	—	No	Occupation	1165	X	
Mountrail, ND	—	—	No	Occupation	1167	X	
Mountrail, ND	—	—	No	Occupation	1168	X	
Mountrail, ND	—	—	No	Occupation	1170	X	
Mountrail, ND	32MN102	--	No	Tipi rings	1170	X	
Mountrail, ND	—	—	No	Occupation	1172	X	
Mountrail, ND	—	--	No	Tipi ring	1170	X	
Mountrail, ND	32MN104	--	No	Tipi rings	1172	X	
Mountrail, ND	—	—	No	Occupation	1174	X	
Mountrail, ND	—	—	No	Occupation	1175	X	
Mountrail, ND	32MN105	--	No	Tipi rings	1176	X	
Mountrail, ND	—	—	No	Occupation	1177	X	
Ward, ND	—	—	No	Habitation	1180	X	
Ward, ND	—	—	No	Habitation	1197	X	
Ward, ND	--	--	No	Habitation	1197	X	
Ward, ND	—	--	No	Habitation	1197	X	

TABLE 2.1-7 PREHISTORIC ARCHEOLOGICAL SITES ALONG THE PROPOSED NORTHERN TIER PIPELINE CORRIDOR

County, State	Site Number	Site Name	National Register	Site Type	Location By Pipeline Mile	Within 2-Mile Study Corridor	Outside Study Corridor
Ward, ND	—	—	No	Habitation	1197	X	
Ward, ND	—	—	No	Habitation	1198	X	
Ward, ND	—	—	No	Habitation	1199	X	
Ward, ND	—	—	No	Habitation	1199	X	
Ward, ND	32WD101	—	No	Rock structures	1200	X	
Ward, ND	32WD102	—	No	Rock structures	1200	X	
Ward, ND	—	—	No	Habitation	1200	X	
Ward, ND	—	—	No	Habitation	1200	X	
Ward, ND	—	—	No	Habitation	1200	X	
Ward, ND	—	—	No	Habitation	1200	X	
Ward, ND	—	—	No	Habitation	1200	X	
Ward, ND	32WD103	—	No	Burial mound	1201	X	
Ward, ND	32WD104	—	No	Rock structure	1201	X	
Ward, ND	—	—	No	Habitation	1201	X	
Ward, ND	—	—	No	Habitation	1201	X	
Ward, ND	—	—	No	Habitation	1201	X	
Ward, ND	—	—	No	Habitation	1201	X	
Ward, ND	—	—	No	Habitation	1202	X	
Ward, ND	—	—	No	Habitation	1205	X	
Grand Forks, ND	32GF324	—	No	Occupation	1386	X	
Grand Forks, ND	32GF3	—	No	Burial mound	1387	X	
Grand Forks, ND	—	—	No	Habitation	1387	X	
Grand Forks, ND	—	—	No	Occupation	1387	X	
Grand Forks, ND	32GF4	—	No	Occupation	1388	X	
Grand Forks, ND	32GF2	—	No	Campsite	1388	X	
Grand Forks, ND	—	—	No	Occupation	1391	X	
Grand Forks, ND	—	—	No	Burial mounds	1392	X	
Polk, MN	21PL3	Engel site	No	Habitation	1423	X	

Sources: Personal Communications 1978
Washington Archaeological Research Center, Washington State University, Pullman, Washington
Washington Office of Archaeology and Historic Preservation, Olympia, Washington
U.S. Department of Agriculture, Forest Service: Mt. Baker-Snoqualmie National Forest Supervisor's Office. Seattle, Washington, and Region 1 Office, Missoula, Montana
Idaho State Historical Society, Boise, Idaho
Montana Histroical Society, Helena, Montana
University of Montana, Missoula, Montana
State Historical Society of North Dakota, Bismarck, North Dakota
Minnesota Historical Society, St. Paul, Minnesota

Prehistoric petroglyphs

Bureau of Land Management

TABLE 2.1-72 HISTORICAL SITES POTENTIALLY AFFECTED BY THE PROPOSED NORTHERN TIER PIPELINE PROJECT

County, State	Site Number	Site Name	National Register	Site Type	Location By Pipeline Mile	Within 2-Mile Study Corridor	Outside Study Corridor
Clallam, WA	—	Fairview School House	No	Early 20th century rural school	1	X	
Clallam, WA	—	McCleary School House	No	Early 20th century rural school	5	X	
Clallam, WA	—	Sequim View Cemetery	No	Historic Cemetery	9	X	
Clallam, WA	—	Port Williams	No	Historic Port	11	X	
Island, WA	—	Central Whidbey Island Historic District and Ebey's Landing National Historic Reserve	Yes	Historic land claims and structures	30, 31	X	
Island, WA	45IS93	Fort Nugent Blockhouse Site	No	Historic military installations	32	X	
Island, WA	—	Utsalady Mill	No	Mill site	51	X	
Island, WA	—	Camano Island Pioneer Cemetery	No	Historic cemetery	52	X	
Snohomish, WA	—	Pearson House	Yes	Historic home	55	X	
Snohomish, WA	—	First Norwegian Settlers Marker and Pioneer Cemetery	No	Historic cemetery and Monument	56	X	
Snohomish, WA	—	Pioneer Cemetery	No	Historic Cemetery	56	X	
Snohomish, WA	—	Settoe Log Cabin	No	Historic cabin	57	X	
Snohomish, WA	—	Hartford to Monte Cristo Railroad District	No	Historic Mining and Transportation	83	X	
Snohomish, WA	45SN38	———	No	Native American campsite and midden	89		
King, WA	—	Fort Tilton	No	Mid-19th century military fort	120	X	
King, WA	—	Snoqualmie Pass wagon road	No	19th century transportation, commerce and settlement	128-166	X	
King, WA	—	Cabin	No	19th century settlement	130	X	
King, WA	—	Cabin	No	19th century settlement	132	X	
King, WA	—	Cabin and mining claim	No	19th century mining and settlement	134	X	
King, WA	—	Homestead	No	19th century settlement	135 Vicinity	Probably	
King, WA	—	Alice Mine, Tramroad and Mill	No	19th and early 20th century mining and technology	136	X	
King, WA	—	Camp Mason (Bide-A-Wee)	No	19th century transportation	136	X	
King, WA	—	Cabins	No	19th century settlement	138	X	
King, WA	—	McClellan cabin	No	19th century transportation and commerce	142	X	
King, WA	—	Rockdale Townsite	No	19th century railroad construction crew town	143	X	
Kittitas, WA	—	Mine shaft, well house, and tramway	No	19th century mining and settlement	146	X	
Kittitas, WA	—	Boat Landing	No	19th and early 20th century transportation and commerce	147	X	
Kittitas, WA	—	Several homesteads	No	19th and early 20th century settlement	153-155	X	
Kittitas, WA	—	Tunnel city site	No	19th century railroad construction crew town	155	X	
Kittitas, WA	—	Cabin	No	19th century settlement	159	X	
Kittitas, WA	—	Cabins	No	19th century settlement	163-164	X	
Kittitas, WA	—	Nelson's iron mine	No	19th century mining	165	X	
Kittitas, WA	—	Several homesteads	No	19th century settlement	166 Vicinity	X	
Kittitas, WA	—	Indian John homestead	No	19th and early 20th century settlement	180	X	
Kittitas, WA	—	Springfield farm/Dr. John Robbins homestead	Yes	19th century settlement	192	X	
Kittitas, WA	—	Colockum Pass Road	No	Native American trail and road for 19th century settlers	203-205; 207-209	X	
Grant, WA	—	Stone igloos (beehive ovens)	No	Late 19th and early 20th century railroad construction crew	225	X	
Grant, WA	—	White Bluffs and Chelan Road	No	19th century transportation and settlement	250	X	
Grant, WA	—	Cariboo Trail	No	19th century transportation and settlement	261	X	
Grant, WA	—	White Bluffs wagon road	No	19th century transportation and settlement	271	X	
Lincoln, WA	—	Crab Creek to Cow Creek wagon road	No	19th century transportation and settlement	299	X	
Lincoln, WA	—	Unnamed trails and roads	No	19th century transportation and settlement	298-313	X	
Lincoln, WA	—	Columbia River Road	No	19th century transportation and settlement	313	X	
Lincoln, WA	—	White Stone Road	No	19th century transportation and settlement	313-314	X	
Lincoln, WA	—	Unnamed road	No	19th century transportation and settlement	314	X	
Lincoln, WA	—	Unnamed trail	No	19th century transportation and settlement	319-322	X	
Lincoln, WA	—	Colville Road	No	19th century military and commercial transportation	320-322	X	
Lincoln, WA	—	Mary Queen of Heaven Church	No	19th century county courthouse and parochial boarding school	322	X	
Spokane, WA	—	Mullan Road and historic Monument	Natl. Hist Civil Eng. Landmark	19th century military, commercial, and settler history	335	X	
Spokane, WA	—	Texas Road	No	19th century transportation and settlement	340	X	
Spokane, WA	—	Mail Road from Walla	No	19th century tranpsortation and settlement	345	X	
Spokane, WA	—	Steptoe campsite	No	19th century military and Native American hostilities	348	X	
Spokane, WA	—	Kentuck Trail	No	19th century transportation and settlement	353	X	
Spokane, WA		Mullan Road-original route south of Coeur d'Alene Lake	No	19th century military road construction and transportation	355-396	Probably	
Shoshone, ID	—	Mullan Road	Natl. Hist Civil Eng. Landmark	19th century military, commerce and settlement	410-414	X	
Shoshone, ID	—	Jackass trail	No	Historic, and probably prehistoric trail	421-431	X	
Shoshone, ID	—	White Peak Lookout	No	Forest Service history	426	X	
Shoshone, ID	—	Delta	No	Historic Mining town	431	X	

TABLE 2.1-72 HISTORICAL SITES POTENTIALLY AFFECTED BY THE PROPOSED NORTHERN TIER PIPELINE PROJECT

County, State	Site Number	Site Name	National Register	Site Type	Location By Pipe-line Mile	Within 2-Mile Study Corridor	Outside Study Corridor
Shoshone, ID	10SE208	—	No	Historic Cabin	431	X	
Shoshone, ID	--	Thiard	No	Historic mining town	432	X	
Shoshone, ID	--	Golden Chest Mine	No	Mining history	436	X	
Shoshone, ID	--	Littlefield Townsite	No	Historic mining town	437	X	
Shoshone, ID	--	Raven Townsite	No	Historic mining town	438	X	
Shoshone, ID	—	--	No	6 historic structures	438	X	
Shoshone, ID	—	Sullivan Townsite	No	Historic mining town	441	X	
Sanders, MT	24SA49	—	No	Historic cabin	448	X	
Sanders, MT	24SA45	--	No	Historic mining	449	X	
Sanders, MT	24SA46	Mountain House	No	Stage coach rest stop	452	X	
Sanders, MT	24SA81	—	No	Historic sawmill	457	X	
Sanders, MT	--	Salish House I	Design Pending	Early 19th century fur trading post	464	X	
Sanders, MT	—	Salish House II	No	Hudson's Bay Company Fur Trading Post	473	X	
Sanders, MT	--	Plains	No	Town with historic buildings	488	X	
Sanders, Mt	—	Paradise	No	Town with historic buildings	494	X	
Missoula, MT	24MO54	—	No	Mining camp	507	X	
Missoula, MT	24MO53	--	No	Mining cabins	507	X	
Missoula, MT	24MO52	—	No	Mining cabins	507	X	
Missoula, MT	24MO109	—	No	Mining cabin	507	X	
Missoula, MT	24MO107	--	No	Cabin	508	X	
Missoula, MT	24MO43	--	No	Mining Cabin	510	X	
Missoula, MT	24MO86	--	No	Cabin	518	X	
Missoula, MT	24MO39	--	No	Cabin	524	X	
Missoula, MT	24MO106	--	No	Ranger station	534	X	
Missoula, MT	—	Mullan Road	Natl. Hist Civil Eng. Landmark	19th century military, freight and transport route	553-556	X	
Missoula, MT	--	Trail followed by Col. Gibbon to Battle of Big Hole	-	Nez Perce and U.S. military history	555	X	
Missoula, MT	--	Lewis and Clark Trail (Lewis in 1806)	No	Early 19th century exploration route	555-566	X	
Granite, MT	24GN111	Nelson Spring	No	Historic mining, and possibly other activities	591	X	
Granite, MT	24GN110	Mystery Mill	No	Historic saw mill site	592	X	
Granite, MT	24GN109	Johnson Cabin	No	Historic cabin	593	X	
Granite, MT	24GN112	The Gold Mine	No	Historic mining	594	X	
Granite, MT	24GN107	Shifman's Saw Mill	No	19th century saw mill site	594	X	
Powell, MT	24PW308	Manley Homestead	No	19th century settlement	600	X	
Powell, MT	24PW59	Blackfoot city	No	Historic mining town	628	X	
Lewis and Clark, MT	--	Mullan Road	Natl. Hist Civil Eng. Landmark	19th century military, commerce, transportation, mining and transportation	645	X	
Lewis and Clark, MT	—	Fort William Henry Harrison	No	Late 19th to early 20th century military affairs	652	X	
Lewis and Clark, MT	--	Broadwater Hotel and and Spa	No	Social history	653	X	
Lewis and Clark, MT	—	Wassweiler Hotel and Bath Houses	Yes	19th and 20th century commerce and recreation	653	Probably	
Lewis and Clark, MT	--	Green Meadow Ranch	No	Early 20th century ranch	655	X	
Lewis and Clark, MT	--	Fort Benton--Helena Stage Road	No	Mid 19th century transportation route	657	X	
Lewis and Clark Broadwater Meagher, and Wheatland, MT	—	Carrol Road	No	Mid 19th century freighting route	664-690, 700-765 with some breaks	X	
Broadwater, MT	--	Lewis and Clark Trail	No	Early 19th century exploration route	690	X	
Wheatland, MT	—	Trail followed by Lts Doane and DeRudio and Crow scouts from Judith Gap to Bozeman	No	Nez Perce and U.S. military history	757 Vicinity	X	
Wheatland, MT	--	Trail followed by Gen. Howard in pursuit of Nez Perce-Sept. 1877	No	Nez Perce and U.S. military history	764 Vicinity	X	
Wheatland, MT	--	Trail followed by Nez Perce in flight from U.S. military	No	Nez Perce and U.S. military history	786 Vicinity	X	
Wheatland, MT	--	Billings to Great Falls Stage Road	No	19th century transportation route	795 Vicinity	X	
Golden Valley, MT	--	—	No	Early 20th century rural school	809	X	
Golden Valley, MT	--	Billings to Fort Benton Stage Road	No	Late 19th and early 20th century transportation route	811	X	
Golden Valley, MT	--	--	No	Early 20th century rural school	814	X	
Musselshell, MT	—	—	No	Early 20th century rural school	824	X	
McCone, MT	24MC60	—	No	Historic Native American occupation	959	X	
Richland, MT	—	--	No	Historic Site; type not known	1057	X	
Richland and Roosevelt, MT	—	Lewis and Clark Trail	No	Early 19th century exploration route	1072	X	
Richland and Roosevelt, MT	--	Snowden (Nohly) Bridge	No	Early 20th century railroad bridge	1072	X	
Roosevelt, MT and Williams, ND	—	Mondak Townsite	No	Early 20th century town	1074	X	
Roosevelt, MT and Williams, ND	—	Fort Union Trading Post	Yes Natl. Hist. site	Fur trading post	1074		X
Williams, ND	—	Fort Buford	Yes	Mid to late 19th century military post	1075	X	
Williams, ND	--	Head Coal Mine	No	Historic mining	1094	X	
Williams, ND	—	Coulter Coal Mine	No	Historic mining	1095	X	
Williams, ND	--	Good Coal Mine	No	Historic mining	1098	X	
Williams, ND	--	Spring Brook Townsite	No	Historic settlement	1106	X	
Williams, ND	--	Morrow Coal Mine	No	Historic mining	1108	X	
Williams, ND	—	Wheelock Townsite	No	Historic settlement	1116	X	
Williams, ND	--	Clarence Iverson No. 1	No	Technological history	1129	X	
Mountrail, ND	—	Mosque	No	Historic architecture/religion	1150	X	
Ward, ND	—	Lloyd Coal Mine	No	Historic mining	1197	X	
Ward, ND	—	Scott Coal Mine	No	Historic mining	1197	X	
Ward, ND	—	Seed Coal Mine	No	Historic mining	1199	X	
Ramsey, ND	32RY404	--	No	Historic Site; type not known	1318	X	
Ramsey, ND	32RY403	Grand Harbor Townsite	No	Historic settlement	1319	X	
Ramsey, ND	—	Midway Post Office	No	Historic settlement	1335	X	

TABLE 2.1-72 HISTORICAL SITES POTENTIALLY AFFECTED BY THE PROPOSED NORTHERN TIER PIPELINE PROJECT

County, State	Site Number	Site Name	National Register	Site Type	Location By Pipeline Mile	Within 2-Mile Study Corridor	Outside Study Corridor
Ramsey, ND	--	Tracy Post Office	No	Historic settlement	1339	X	
Ramsey, ND	--	Bartlett Townsite	No	Historic settlement	1346	X	
Nelson, ND	—	Mapes Townsite	No	Historic settlement	1354	X	
Nelson, ND	—	Michigan City Townsite	No	Historic settlement	1361	X	
Nelson, ND	--	Petersburg Townsite	No	Historic settlement	1367	X	
Grand Forks, ND	—	Niagara Townsite	No	Historic settlement	1373	X	
Grand Forks, ND	—	—	No	Rural school house	1383	X	
Grand Forks, ND	--	--	No	Rural school house	1387	X	
Grand Forks, ND	—	Arvilla Townsite	No	Historic settlement	1392	X	
Grand Forks, ND	—	—	No	Rural school house	1397	X	
Grand Forks, ND	—	--	No	Rural school house	1405	X	
Grand Forks, ND	—	--	No	Rural school house	1409	X	
Grand Forks, ND	--	--	No	Log Cabin	1416	X	

Sources: Washington Archaeological Research Center; Washington State University; Pullman, Washington
Washington Office of Archaeological and Historic Preservation, Olympia, Washington
General Land Office Survey Plats for Washington; BLM-Oregon State Office; Portland, Oregon
U.S. Dept. of Agriculture, Forest Service; Mt. Baker-Snoqualmie National Forest Supervisors Office; Seattle, Washington, and Region 1 office, Missoula, Montana
Idaho State Historical Society, Boise, Idaho
Montana Historical Society, Helena, Montana
State Historical Society of North Dakota, Bismarck, North Dakota
Elmendorf 1960.

TABLE 2.1-73 PALEONTOLOGICAL RESOURCES ALONG THE PROPOSED NORTHERN TIER PIPELINE CORRIDOR

County and State	Formation	Age	Type of Locality or Type of Sediment With Potential for Containing Fossils	Location by Pipeline Mile	Within or Crossed by 2-mile Study Corridor
Clallam, WA	Twin River	Oligocene-Miocene	Marine sedimentary rocks	0-8	X
Clallam, WA	Twin River	Oligocene-Miocene	Fossil locality	3	X
Clallam, WA	Various	Younger Quarternary	Glacial drift and till	8-12	X
Island Snohomish, and King, WA	Various	Younger Quarternary	Glacial drift and till, peat, alluvium, and terrace deposits	30-130 with a few minor breaks	X
Snohomish, WA		Oligocene	Potential fossil locality at South Fork Stillaguamish River Crossing	69-70	X
Kittitas, WA		Quaternary	Unconsolidated alluvium	150-182	X
Kittitas, WA		Quaternary	Unconsolidated alluvium	189-194	X
Kittitas, WA	Ellensburg	Miocene	Petrified tree	222	Probably
Grant, WA		Quaternary	Periglacial eolian deposits	224-246	X
Grant, WA		Quaternary	Younger glacial drift	246-264 with minor breaks	X
Grant and Lincoln, WA		Quaternary	Periglacial eolian deposits	270-302	X
Spokane, WA and Benewah, ID		Quaternary	Periglacial eolian deposits	345-370 with some breaks	X
Benewah, ID		Quaternary	Alluvium	385-387	X
Shoshone, ID		Quaternary	Alluvium	410-414	X
Sanders, MT		Quaternary	Alluvium	447-500	X

TABLE 2.1-73 PALEONTOLOGICAL RESOURCES ALONG THE PROPOSED NORTHERN TIER PIPELINE CORRIDOR

County and State	Formation	Age	Type of Locality or Type of Sediment With Potential for Containing Fossils	Location by Pipeline Mile	Within or Crossed by 2-mile Study Corridor
Missoula, MT		Tertiary and Quaternary	Sedimentary rocks, glacial drift and alluvium	507-568	
Powell, MT		Quaternary	Alluvium	605-622	X
Powell, MT,		Tertiary	Undifferentiated sedimentary rocks	622-634	X
Powell and Lewis and Clark, MT	Mainly Kootenai and unnamed older formations	Mississipian, Pennsylvanian, Permian, Jurassic, and Cretaceous	Various sedimentary rocks, some undifferentiated	634-640	X
Lewis and Clark and Broadwater, MT		Quaternary	Alluvium	653-663 674-678 689-696	X
Lewis and Clark and Broadwater, MT		Tertiary	Undifferentiated sedimentary rocks	663-674 678-689 696-700	X
Meagher, MT		Tertiary	Undifferentiated sedimentary rocks	718-725	X
Meagher, MT	Colorada Shale, Eagle Sandstone, Bearpaw Shale	Cretaceous and Tertiary	Various sedimentary rocks	725-741	X
Meagher and Wheatland, MT		Quaternary	Alluvium	741-758	
Wheatland, MT	Colorado Shale, Eagle Sandstone Clagget, Judity River and unnamed Teriary formations	Cretaceous and Tertiary	Various sedimentary rocks, some undifferentiated	758-774	X
Wheatland and Golden Valley, MT		Tertiary and Quaternary	Terrace deposits	774-785 792-818	X
Wheatland, MT	Bearpaw Shale	Cretaceous	Shale	785-792	X
Golden Valley, MT	Judith River	Cretaceous	Various sedimentary rocks	814-816	X
Golden Valley, Musselshell, Fergus, and Petroleum, MT	Mostly Colorado Shale and Terrace deposits with some Kootenai, Eagle Sandstone and alluvium	Cretaceous, Tertiary and Quaternary	Various sedimentary rocks ans unconsolidated sediments, some undifferentiated	818-851	X
Petroleum, MT	Eagle Sandstone	Cretaceous	Sandstone	851-857	X
Petroleum, MT	Claggett and unnamed alluvium	Cretaceous and Quaternary	Various sedimentary rocks with unconsolidated alluvium in stream valleys	857-871	X
Petroleum and Garfield, MT	Colorado Shale Eagle Sandstone Claggett, Judith River, Bearpaw Shale, Fox Hills Sandstone and Hell Creek	Cretaceous	Various sedimentary rocks, some with dinosaur and invertebrate fossils	871-895	X
Garfield, MT	Fort Union and Unnamed alluvium	Tertiary and Quaternary	Various sedimentary rocks with plant and animal fossils and unconsolidated alluvium in stream valleys	895-954	X
Garfield, MT	Hell Creek	Cretaceous	Sedimentary rocks with dinosaur fossils, discontinously overlain by glacial drift	954-956	X
Garfield and McCone, MT	Fort Union	Tertiary	Sedimentary rocks with plant and animal fossils, discontinuously overlain by glacial drift	956-971	X

TABLE 2.1-73 PALEONTOLOGICAL RESOURCES ALONG THE PROPOSED NORTHERN TIER PIPELINE CORRIDOR

County and State	Formation	Age	Type of Locality or Type of Sediment With Potential for Containing Fossils	Location by Pipeline Mile	Within or Crossed by 2-mile Study Corridor
McCone, MT	Fort Union	Tertiary	Various sedimentary rocks with plant and animal fossils	971-993	X
McCone and Richland, MT	Fort Union	Tertiary	Sedimentary rocks with plant and animal fossils, discontinuously overlain by glacial drift	993-1071	X
Richland and Roosevelt, MT		Quaternary	Unconsolidated alluvium	1071-1074	X
Roosevelt, MT; Williams and Mountrail, ND	Fort Union	Tertiary	Sedimentary rocks with plant and animal fossils, discontinously overlain by glacial drift	1074-1143	X
Williams, ND	Sentinel Butte	Tertiary	Invertebrate fossil locality	1077	X
Ward, ND	Fort Union	Tertiary	Sedimentary rocks with plant and animal fossils may be exposed in river valleys	1197-1201	X
Grand Forks, ND	Niobrara	Cretaceous	Invertebrate fossil locality	1378	X
Grand Forks, ND	Niobrara	Cretaceous	Vertebrate fossil locality	1378	X
Grand Forks, ND		Quaternary	Lake Delta and Beach Ridge deposits with potential for vertebrate fossils	1380-1397	X
Grand Forks, ND		Quaternary	3 invertebrate fossil localities	1392	X
Polk, MN		Quaternary	Several Beach Ridge deposits with potential for vertebrate fossils	1429-1439	X
Red Lake, MN	Campbell Beach of glacial Lake Agassiz	Quaternary	Beach Ridge deposits with potential for vertebrate fossils	1442-1447	X

Sources: Washington Environmental Atlas 1975; U.S. Army Corps of Engineers, Seattle District, Seattle, Washington
Washington Archaeological Research Center; Washington Department of Natural Resources, Olympia, Washington
Geologic Map of Washington, 1961; Washington Department of Natural Resources, Olympia, Washington
New State of Idaho Geologic Map (compilation stage), 1977; Idaho Bureau of Mines and Geology
Geologic Map of Montana, 1955; U.S. Geological Survey
Department of Geology; University of Montana; Missoula, Montana
Guide to the Geology of Northwest North Dakota, by John P. Bluemle, 1976; North Dakota Geological Survey
Geologic Highway Map of North Dakota, by John P. Bluemle, 1977; North Dakota Geological Survey
Department of Anthropology; University of Minnesota, Minneapolis, Minnesota

Historic house

Bureau of Land Management

Old logging camp

Bureau of Land Management

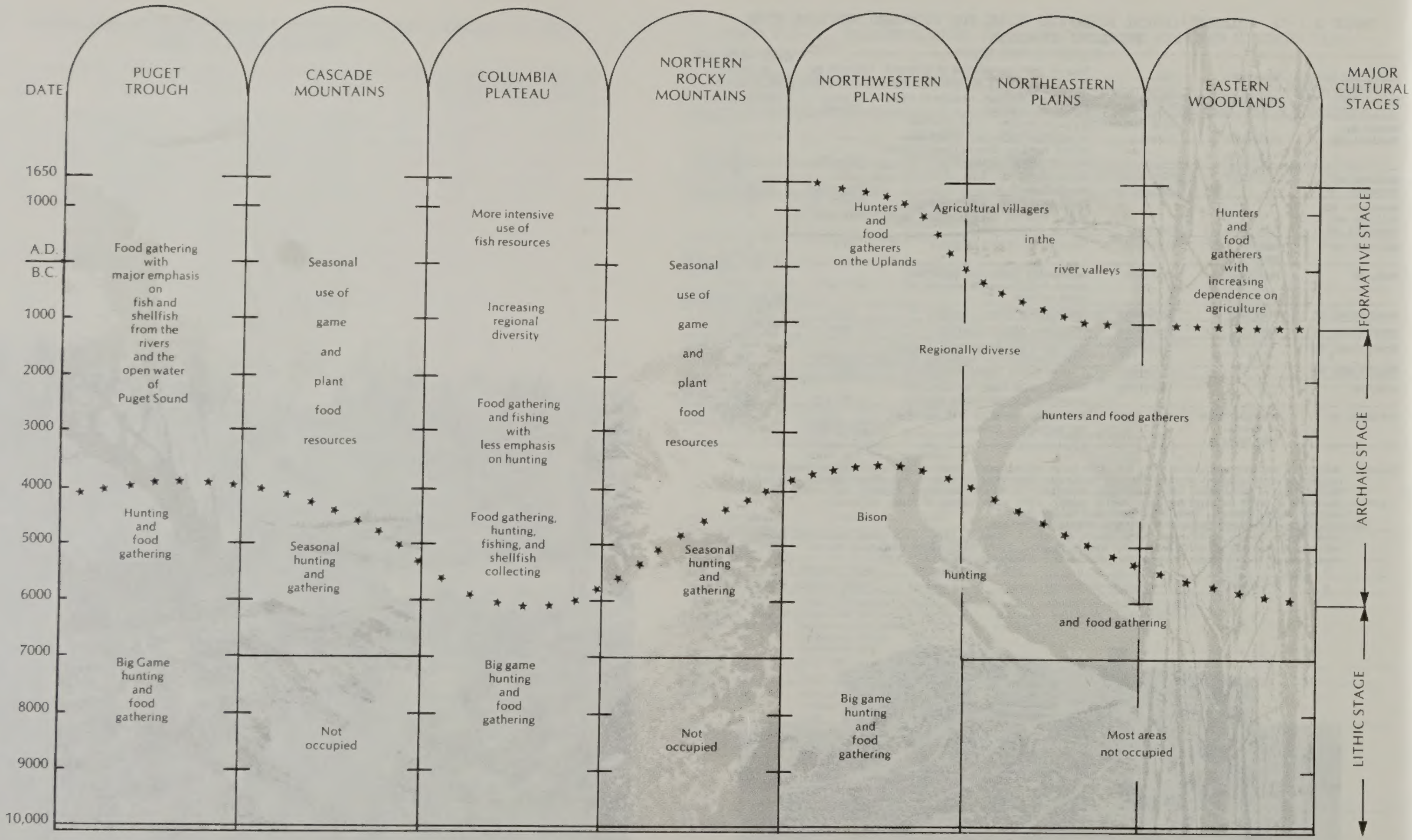

DATE
PUGET TROUGH
CASCADE MOUNTAINS
COLUMBIA PLATEAU
NORTHERN ROCKY MOUNTAINS
NORTHWESTERN PLAINS
NORTHEASTERN PLAINS
EASTERN WOODLANDS
MAJOR CULTURAL STAGES
1650
1000
A.D.
B.C.
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
Food gathering with major emphasis on fish and shellfish from the rivers and the open water of Puget Sound
Hunting and food gathering
Big Game hunting and food gathering
Seasonal use of game and plant food resources
Seasonal hunting and gathering
Not occupied
More intensive use of fish resources
Increasing regional diversity
Food gathering and fishing with less emphasis on hunting
Food gathering, hunting, fishing, and shellfish collecting
Big game hunting and food gathering
Seasonal use of game and plant food resources
Seasonal hunting and gathering
Not occupied
Hunters and food gatherers on the Uplands
Agricultural villagers in the river valleys
Regionally diverse
Bison
hunting
Big game hunting and food gathering
Hunters and food gatherers with increasing dependence on agriculture
hunters and food gatherers
and food gathering
Most areas not occupied
FORMATIVE STAGE
ARCHAIC STAGE
LITHIC STAGE

Figure 2.1-20

PREHISTORIC CHRONOLOGY FOR AREAS CROSSED

by Proposed Northern Tier Pipeline Company

The historical resource sites listed in table 2.1-72 are in the files of state historical societies and similar institutions. As with archaeological sites, the list is incomplete. Not included are sites which might be known to specialized historians, sites mentioned in documentary literature, and sites of generally recognized historical value not yet officially recorded and evaluated.

Those sites listed in (or eligible for inclusion in) the latest edition of the National Register of Historic Places (February 6, 1979) and monthly supplements through June 5, 1979, are indicated in table 2.1-72. Some are archaeological sites. Some resources include standing structures and some, such as portions of trails, have no physical remains. Few sites have been listed in the National Register and even fewer developed to contribute to public awareness and understanding of the past. An assessment of their value and potential contribution awaits further study by historians. Potential exists along the proposed pipeline route for the recognition and discovery of unrecorded historical resource sites.

Paleontological Resources

Paleontological resources are fossils (including pollen and spores) of plants and animals. The study of fossils contributes to our understanding of past environments, to our knowledge of changing plant and animal communities, to the identification of deposits containing economically important minerals, and to our understanding of prehistoric human life. Fossils, like other cultural resources, are rare, fragile, irreplaceable, and nonrenewable.

The systematic recording of sites and rock formations known or presumed to contain fossils is just beginning. Table 2.1-73 lists the few fossil-bearing localities and rock formations identified along the proposed pipeline route. Later Pleistocene Age sediments have potential for human skeletal remains and cultural material along with vertebrate fossil remains.

VISUAL RESOURCES

The proposed pipeline route has been divided into 10 distinct segments to reflect differences in terrain and vegetation. Each segment is described in terms of scenic quality and visual sensitivity.

Scenic quality is determined by evaluation of landform, vegetation patterns, water features, and human impacts, if any. A rating of A/B or C is assigned according to the Bureau of Land Management visual resource management system, similar to that used by the U.S. Forest Service (Landscape Management System USDA Handbook 462). Segments having moderate to high scenic quality were rated A/B and possess one or more of the following: landform relief; rock outcroppings; mosaics of forest, woodland, or brush interspersed with meadows or pastoral land; and lakes, rivers, or other prominent water features. They are also relatively free of intrusions such as high voltage transmission lines. Flat featureless expanses with uniform vegetative cover are considered to be of low scenic quality and rated C. Agricultural land and urbanized areas also tend to have low scenic quality.

The visual sensitivity of each segment depends upon the individual observer. Areas of moderate to high sensitivity are those visible from roads, recreational sites, bodies of water, or communities. Visibility from a wilderness, natural area, or wildlife refuge would also be highly sensitive. Low sensitivity areas would be those sparsely populated areas.

The distance of the view site from the project site is a major consideration of visual sensitivity. A location within 0 to 5 miles is in a foreground/middleground visual zone; one from 5 to 15 miles in the background visual zone. Much of the proposed corridor lies in remote, seldom seen areas.

Judgments of scenic quality and visual sensitivity can be combined to establish visual management quality objective classes. These classes determine what each landscape type requires to maintain its visual quality. Visual quality objective classes used in this discussion are also derived from the BLM and USFS systems: Class I - areas of high scenic quality; Class II - human alterations should not be visually evident in the landscape (similar to USFS retention class); Class III - human alterations should be visually subordinate to the landscape (similar to USFS partial retention class). There are no Class I areas within the project route.

Segment 1 -- The North Shore of the Olympic Peninsula Cross-Sound to North Bend (pipeline mile 0 to 125.8)

From Green Point to near Port Williams the terrain is low, rolling foothills. Whidbey and Camano Islands and the shorelands of north Puget Sound are characterized by gently sloping lands. Rolling foothills and mountains dominate the terrain from Stanwood to North Bend. The proposed pipeline would enter the Strait of Juan de Fuca near Port Williams by descending a 50-foot bluff to the shoreline; the ascent from the Strait at Whidbey Island, near Partridge Point, traverses up a 35-foot bluff and continues through a beach access slot. Both of these bluff traverses are in the immediate foreground view of Sequim Bay and vessels in the Sound. At Brown Point the submarine line would extend through and up an 80-foot bluff and would be in the immediate foreground view of vessels in Saratoga Passage.

Generally, vegetation is coniferous with some deciduous trees in the drainages. Broad open agricultural areas, pastureland, residential development, and bodies of water typify this segment.

Farms, homes, and rural developments are in the foreground/middleground zone of the proposed corridor,including the towns of Carlsborg, Sequim, and Port Williams on the Olympic Peninsula; Coupeville, Oak Harbor, and a naval reservation on Whidbey Island; Camano Island residents; and Stanwood, Arlington, Snohomish, and North Bend as well as several smaller communities.

U.S. Interstate 5 would be crossed 6 miles east of Stanwood; State Highway 2 would be crossed near Snohomish. Many other state and county roads would be parralled or crossed in this segment and are in the foreground/middleground visual zone. Number 2, Arlington, and Number 3, Carnation, pump stations would be located on agricultural land, with some tree cover.

Overall, this segment has high scenic quality (A/B), high visual sensitivity, and is in visual management quality class II.

Segment 2--The Cascades (pipeline mile 125.8 to 181.5)

The segment over the Cascade Mountains extends from North Bend to the Yakima River. Landform in the Cascades is high relief with steeply sloping mountainsides and narrow valley bottoms. Vegetation is largely dense coniferous forests. Bodies of water near the proposed pipeline route include Echo, Easton, and Keechelus Lakes and the Snoqualmie and Yakima Rivers. Man-made intrusions include Interstate 90 and high voltage transmission lines cut through the dense forest cover. Overall scenic quality is high (A/B).

The proposed route over the Cascades traverses an area of high visual sensitivity; much of it would be within the foreground/middleground visual zone of Interstate 90, a designated scenic highway. The proposed pipeline route would cross the Pacific Crest National Scenic Trail and would be visible from several other hiking trails. It would be within the foreground/middleground visual zone of the Snoqualmie Pass ski areas, and crosses heavily used snowmobiling and cross-country skiing areas in the Wenatchee and Snoqualmie National Forests. The proposed route would be in the foreground/middleground visual zone of Keechlus Lake, which receives heavy year-round recreational use. Number 4, Bandera pump station (pipeline mile 136.7) would be located in a forested area south of the South Fork of the Snoqualmie River and Interstate 90 and would be in the immediate foreground visual zone of highway travelers.

The high visual sensitivity and high scenic quality (A/B) of the Cascades segment place it in visual management quality class II.

Segment 3--Wenatchee (pipeline mile 181.5 to 223.7)

This segment extends from the Yakima River to the Columbia River.

The landform is gently rolling uplands incised by intermittent drainage courses and ridges. Vegetative patterns are grasslands interspersed with croplands, scattered coniferous trees with some dense pockets, and expansive treeless areas. The power-line corridor through this segment intrudes to varying degrees as it proceeds through open croplands and timbered areas. Number 5, Ellensburg pump station site would be in a seldom seen area.

There are no areas of high visual sensitivity except the Yakima River crossing. The proposed route would be in the foreground zone of Interstate 90 on the west and of county road 10 on the east. The overall scenic quality of this segment is rated A/B Class III.

Segment 4--Columbia Plateau (pipeline mile 223.7 to 367)

This segment of the proposed pipeline route extends from the Columbia River to the Idaho state line. The landform is generally of low relief, gently rolling uplands incised by old drainage channels of the Columbia River. Some foothills are traversed near the Idaho border. As the proposed route skirts the town of Sprague and progresses eastward, road networks and residential development increases. Grasslands are interspersed with croplands, deciduous trees, and shrubs in draws and drainages. Two irrigation canals, Rocky Ford and Crab Creeks, and several small streams and drainages are crossed. There are no man-made intrusions of any consequence. The areas proposed for the Number 6, Quincy, Number 7, Odessa, and Number 8, Plaza, pump stations would be in open seldom seen areas.

Since the landforms are relatively flat and repetitious, overall scenic quality is judged to be C, Class III.

Segment 5--Northern Rocky Mountains (pipeline mile 367 to 608)

This segment extends from the Washington-Idaho state line to about 5 miles southeast of Helmville, Montana. The land is steeply sloping, mountainous country with narrow river valley bottoms. The proposed route would follow the crest through the Jackass Ridge section. At lower elevations the terrain becomes hilly to rolling pasture and farmland. The vegetation is dense coniferous forest on the mountains and higher elevations, and Ponderosa woodland with some open areas at lower elevations. Water features include the South Fork Coeur d'Alene River, Prichard, Siegel, Ninemile, and Prospect Creeks, and the Clark Fork, Thompson, and Blackfoot Rivers, all of which lie in the foreground/middleground visual sensitivity zone.

Man-made intrusions include an overhead power transmission line, cuts, fills, and clearings for highways and pipelines along the South Fork Coeur d'Alene River, Prospect Creek, and Prichard Creek drainages.

Number 10 pump station and some sections of the pipeline right-of-way near Enaville would be in foreground/middleground view of residents and Highway 90 travelers. Number 9, Cataldo, and Number 12, Potomac, pump stations would be located in seldom seen areas. Number 11, Paradise pump station would be in the foreground view of town residents and travelers on State Highway 200. The proposed pipeline route through dense forest land would be in the foreground/middleground zone of Thompson Falls. The Clark Fork River and State Highway 200 are crossed about 2.5 miles north of Plains.

Overall scenic quality for this segment is rated C class III.

Segment 6--Eastern Portion of the Northern Rocky Mountains (pipeline mile 608 to 756.4)

This segment would extend from pipeline mile 608 to the Meagher-Wheatland County line in Montana.

Landforms of this segment are transitional with indistinct boundaries. As the route progresses eastward, the Northern Rocky Mountain physiographic province of rugged, mountainous terrain with steep slopes and broad intermontane basins, gradually changes to glacially modified and dissected plateaus blending into rolling to flat plains. Vegetation is correspondingly transitional with coniferous forest on the mountain slopes and scattered Ponderosa woodland at lower elevations. Grasslands with scattered farms and prairies occur in the open plains. Major water crossings are the North Fork of the Blackfoot and Missouri Rivers, and the South Fork of the Smith River. Nevada Lake recreation users would observe pipeline activity in the foreground visual zone.

Number 13, Elliston, and Number 14, Townsend, pump stations would be located in open, seldom seen areas.

The only prominent man-made intrusion in this segment is a power transmission line. However, the relative openness of the woodlands and farmlands and the urban sprawl around Helena, is rated low (C) for overall scenic quality. This segment is in visual management quality objective Class III.

Segment 7--Missouri Breaks (pipeline mile 756.4 to 1100)

This segment begins at the Wheatland-Meagher County line and extends to Williston, North Dakota. Landform in this segment is broken, rolling uplands dissected intermittently by steep drainages. In the northern section glacial-type drain patterns would be crossed.

The vegetative pattern of this segment is scattered ponderosa woodlands giving way to grasslands and a few farms. Major water crossings are the North Fork of the Musselshell River, Haymaker and Flatwillow Creeks, Musselshell River, Big Dry Creek, and the Redwater, Missouri, and Little Muddy Rivers. There are no large man-made intrusions. The Charles M. Russell National Wildlife Refuge would be skirted to the south. Overall scenic quality for this segment is rated C. Visual sensitivity is classified as low due to the low population and relatively flat terrain.

Both the Glacier and Western crude delivery facilities would be located in open farm country in seldom seen areas. Number 15, Harlowton, and Number 17, Richey, pump stations are included as part of the respective delivery facility. Number 16, Gordon pump station would be located in an open field, but in the foreground view of State Highway 200 travelers.

Visual management quality is rated Class III.

Segment 8--Pothole (pipeline mile 1100 to 1207)

This segment would extend from Williston to near Minot, North Dakota. Landform is rolling, hummocky terrain with undrained basins dotting the surface--hence pothole country. Vegetation consists of grasslands, some cropland, and pasture. Water features are the White Earth, Des Lacs, and Souris Rivers.

The AMOCO delivery facility would be located in the Williston oil and gas fields near pipeline 1132. Number 18, Tioga pump station, would be part of the AMOCO delivery facility.

There are few large man-made intrusions in this segment, but being relatively featureless, overall scenic quality is rated C. There are no areas of high visual sensitivity; visual quality objective is Class III.

Segment 9--Plains (pipeline mile 1207 to 1441)

This segment would extend from near Minot east to the Red River. Landform is nearly level, open plain grasslands, with scattered potholes, extensive croplands, and some pastures. The Souris River and many scattered small lakes in the western part of the segment would be crossed. Several small towns, game management areas, and wildlife refuges would be skirted. Several highways would be crossed by the pipeline. It would parallel or cross State Highway 2 for a portion of this segment. Interstate 29, a main north-south highway, would also be crossed. Overall scenic quality is rated C.

Towner pump station 19 would be located in a seldom seen area. Devil's Lake pump station 20 would be in the immediate foreground visual zone of Highway 20 travelers. Crookston pump station 21 would be located in the immediate foreground view of Highway 75 travelers. There are no areas of high visual sensitivity. The visual quality objective for this segment is Class III.

Segment 10--North Woods (pipeline mile 1441 to 1490)

This segment would extend from the Red River in North Dakota to Clearbrook, Minnesota.

The land is a continuation of flat, level plains; some pothole country would be crossed. Vegetation is extensive croplands giving way to deciduous open forest with scattered cropland and pastures.

The Red River and Red Lake River are the only water features. There are no large man-made intrusions. The route would cross State Highways 2 and 59 and several other roads. The existing Clearbrook storage facility would be enlarged. Overall scenic quality is rated C.

There are no areas of high visual sensitivity. The visual management quality for this segment is rated Class III.

Great Plains

U.S. Fish and Wildlife Service

LAND USE

This section discusses land ownership in the vicinity of the proposed pipeline and general categories of land use including urban, agricultural, rangeland, open space, forest, and woodland. Specific land uses such as recreation, mining, and transportation are discussed in other sections. Lands with special management concerns including Native American areas, natural and scientific areas, and wilderness areas, are discussed here. The final component of this section addresses land use plans and zoning within the proposed pipeline corridor. Each topic will be discussed state-by-state for the proposed pipeline route.

On August 30, 1976, the U.S. Council on Environmental Quality issued a memorandum directing federal agencies to consider the impacts of their actions on highly productive farmlands. This and subsequent directives has initiated a program in which the USDA, Soil Conservation Service (SCS), and the states are identifying and designating prime and unique farmlands, and those considered to be of state and local importance.

Although criteria have been established, mapping has not yet been completed, except in North Dakota. Data in table 2.1-74 are therefore based only on the soils criteria.

TABLE 2.1-74 ACRES OF PRIME FARMLAND WITHIN THE PROPOSED RIGHT OF WAY1/

State	Total Acres Within Right-of-Way	Acres of Prime Farmland Within Right-of-Way	Percent of Total
Washington	4,448	1,017	23.0
Idaho	927	42	4.5
Montana	7,648	637	8.3
North Dakota	4,139	1,540	37.2
Minnesota	915	613	67.0
Total	18,077	3,849	21.3

Source:

1/ Average right-of-way width is 100 feet. Computations were made from generalized soil association maps. Soil associations include some unnamed soils that may not be prime farmland soils. No distinction is made between cropland, rangeland, or forestland. The acreage also includes some dryland soils that would be prime farmland if irrigated. The prime farmland acreages are projected from Soil Conservation Service Soil Mapping Unit lists.

Land Ownership

Land ownership within the states traversed by the proposed route is shown in the Map Addendum. Chapter 1 contains a list of the proposed pipeline mileages across federal lands and Indian reservations. Since land ownership patterns are generally a function of land use, they are discussed concurrently.

Land Uses

Significant land uses along the proposed route are summarized by counties and states in the tables that follow and are shown as background on the pipeline route maps (see Map Addendum).

Washington.

See table 2.1-75 for land uses along the proposed pipeline route in Washington.

TABLE 2.1-75 WASHINGTON--LAND USE BY MILES OF PROPOSED PIPELINE

County	Miles	Urban	Agriculture	Rangeland/ Open Space	Forest/ Woodland	Other 1/
Clallam	17	.0	9.1	.0	2.3	5.6
Jefferson	10	.0	.0	.0	.0	10.0
Island	28	0.9	11.5	.0	7.3	8.3
Snohomish	48	0.7	13.4	.0	33.9	.0
King	42	.0	.0	.0	40.5	0.5
Kittitas	79	.0	1.7	29.2	46.1	2.0
Grant	50	.0	16.9	31.2	.0	1.9
Lincoln	39	.0	23.6	15.4	.0	.0
Adams	16	10	16.0	.0	.0	.0
Spokane	38	.0	23.4	11.3	3.3	.0
Total	367	2.6	115.6	87.1	133.4	28.3

1/ Includes vacant land, water, and water-related areas.

Urban. From Green Point to North Bend (pipeline mile 125) the proposed pipeline corridor would pass near numerous urban fringe areas as indicated in table 2.1-69. In Clallam county, there is a developed area north of Sequim. The pipeline corridor would pass near several residential and builtup areas on Whidbey Island and the town of North Bend in King county. In western Washington, dominant land uses are agriculture and forest-woodland, however, residential land use commonly occurs in these areas at relatively high densities. In eastern Washington rural areas are more sparsely populated, and except for occasional farmsteads, the corridor would encounter residential and commercial land uses only near the areas indicated in table 2.1-76.

TABLE 2.1-76 WASHINGTON--CITIES, TOWNS, RURAL CENTERS WITHIN CORRIDOR

County	Name	Population 1/	Location of Corridor Centerline
Clallam	Sequim	2,555 (1977)	1 mile south
Island	Swantown		Adjacent on east
	Oak Harbor	11,618	1 mile northeast
Snohomish	Stanwood	1,463	Adjacent on north
	East Stanwood		Adjacent on southwest
	Bryant		1 mile south
	Arlington	2,675	1/2 mile east
	Lake Stevens	1,208	1/2 mile east
King	North Bend	1,665	1/2 mile south
	Tanner		1/2 mile northeast
Kittitas	Hyak		1/2 mile southwest
	Easton		Adjacent on southwest
	Cle Elum	1,725	1 mile south
Grant	Ephrata	5,320	1/2 mile south
Lincoln	Sprague	555	Adjacent on south
Spokane	Plaza		1/4 mile south
	Waverly	69	1 mile south

Source: State of Washington Office of Financial Management 1977

1/ Towns which do not have populations listed are within the unincorporated areas of the counties.

Agriculture. Agriculture is a significant land use within the corridor throughout most of Washington. West of the Cascades agricultural use consists primarily of improved pasture and truck farming, most often near river floodplains. Individual land holdings are often small, frequently in the range of 5 to 80 acres. In eastern Washington agricultural use and land ownership are less intensive. Crops are primarily grain, both irrigated and nonirrigated. In Grant, Lincoln, and Adams Counties, between pipeline mile 229 and 280, the corridor would cross areas that are potentially irrigable by the U.S. Bureau of Reclamation Columbia Basin Project.

Rangeland/Open Space. West of the Cascades, rangelands and open space lands are not significant in terms of their extent within the corridor. Generally such lands consist of flood plains, unimproved and unirrigated pasture, and cleared forest and brush lands.

East of the Cascades, rangeland/open space is a significant land use as indicated in table 2.1-75.

Forest/Woodlands. Significant amounts of forest/woodland are within the corridor in western Washington. These lands consist of small privately owned woodlots and large corporate and publicly owned forestland. Almost all forest land that would be crossed by the corridor in the Puget Sound region is considered commercially productive.

In eastern Washington, only scattered woodland areas are found within the corridor.

Idaho.

Table 2.1-77, summarizes the land uses by miles of proposed pipeline.

TABLE 2.1-77 IDAHO--LAND USE BY MILES OF PROPOSED PIPELINE

County	Miles	Urban	Agricultural	Rangeland/ Open Space	Forest Woodland	Other
Benewah	21	0	12.3	0	8.4	0.3
Kootenai	22	0	6.2	0	15.6	0.2
Shoshone	33	1.0	2.3	0	27.8	1.9 1/
Total	76	1.0	20.8	0	51.8	2.4

1/ Includes vacant land, water, and water-related areas.

Urban. The proposed corridor would avoid urban areas through Idaho. Some residential and commercial land uses are encountered in the vicinity of the small communities indicated below in table 2.1-78.

TABLE 2.1-78 IDAHO--CITIES, TOWNS, RURAL CENTERS WITHIN CORRIDOR

County	Name	Population	Locations of Corridor Centerline
Benewah	Plummer	579 1/	1/8 mile north
	Chatcolet	80 1/	1/8 mile south
	St Maries	2,820 1/	1 mile northwest
Kootenai	Medimont	30 1/	1/8 mile south
	Cataldo	100 2/	1/8 mile south
Shoshone	Kingston	NA	Immediately adjacent
	Enaville	50 2/	1/4 mile southeast
	Delta	NA	Immediately adjacent
	Murray	100 2/	Immediately adjacent

1/ Bureau of the Census, Population Estimates and Projections 1973 (rev.) and 1975; Population Estimates 1972 (rev.) and 1974; Per Capita Income Estimates for counties and incorporated places in Idaho 1977.

2/ Idaho Official Highway Map 1976-1977 ed.

Agricultural. Most of the agricultural lands within the corridor are nonirrigated. From the Washington-Idaho border to near pipeline mile 380, wheat is the principal crop.

Rangeland/Open Space. Rangeland is not a dominant land use within the corridor. Some of the agricultural lands discussed above are used for pasturing domestic livestock. Livestock also graze on much of the forested land within the corridor.

Forest/Woodland. Most of the land within the corridor is forested. As in western Washington forest lands are in small private, corporate, and public ownership.

Montana

Table 2.1-79, summarizes land uses by miles of proposed pipeline.

TABLE 2.1-79 MONTANA--LAND USE BY MILES OF PROPOSED PIPELINE

County	Miles	Urban	Agriculture	Rangeland/ Open Space	Forest/ Woodland	Other 1/
Sanders	63		16.3	3.0	40.7	3.0
Missoula	73	2.1	6.5	10.8	51.1	2.5
Granite	14		0	0	14.0	0
Powell	43		0.8	31.1	10.8	0.3
Lewis and Clark	32		9.2	11.4	9.0	2.4
Jefferson	1		1.0	0	0	0
Broadwater	44		14.9	21.9	6.0	1.2
Meagher	43		3.2	38.2	1.0	0.6
Wheatland	43		6.9	35.1	0	1.0
Golden Valley	19		2.2	16.8	0	0
Musselshell	17		5.0	12.0	0	0
Fergus	2		0	2.0	0	0
Petroleum	37		4.6	32.4	0	0
Garfield	84		7.6	76.4	0	0
McCone	55		22.8	31.9	0	0.3
Dawson	2		2.1	0	0	0
Richland	56		25.4	30.2	0	0.4
Roosevelt	3		1.2	1.8	0	0
Total	631	2.1	129.6	355.0	132.6	11.7

1/ Includes vacant land, water, and water-related areas.

Urban. The proposed pipeline corridor would pass through the urban fringes of northeast Missoula and north of Helena and Townsend. These and other communities within the proposed pipeline corridor are shown in table 2.1-80. In western Montana, rural subdivisions are within the corridor in Lewis and Clark and Sanders Counties.

TABLE 2.1-80 MONTANA--CITIES, TOWNS, RURAL CENTERS WITHIN CORRIDOR

County	Name	Population	Location of Corridor Centerline
Sanders	Thompson Falls	1,460 1/	1 mile southwest
	Plains	1,046 2/	1 mile southwest
	Paradise	250 2/	1/4 mile southwest
Missoula	Huson	125 2/	1 mile north
	Frenchtown	175 2/	1 mile north
	Missoula	29,497 2/	Adjacent northeast
	Milltown	700 2/	1/2 mile north
	Bonner	185 2/	1/2 mile north
	Rainbow Bend	NA	1/4 mile nortn
Powell	Birdseye	NA	Adjacent on north
Lewis & Clark	Helena	26,251 1/	Through northern fringe
Broadwater	Townsend	1,548 1/	Adjacent on northeast
Meagher	Martinsdale	150 2/	1 mile north
Petroleum	Flatwillow	NA	Adjacent on southwest
Garfield	Sand Springs	4 2/	1 mile southeast

Sources: SRI 1978; Official Montana Highway Map 1977

1/ SRI 1978

2/ The Official Montana 1977 Highway Map

Agricultural. Within Montana, the proposed pipeline corridor encounters irrigated croplands and pasture along flood plains. Significant amounts of irrigated crop lands would be crossed near Helena and Townsend.

Irrigation practices include both gravity and sprinkler systems with sprinkler systems becoming increasingly common.

In western Montana crops are primarily grass-alfalfa hay and winter wheat, while in eastern Montana the corridor would cross mostly nonirrigated crops such as wheat and barley.

SCS has identified as prime farmland one area in Richland County near Fourmile Creek (pipeline mile 1066) consisting of approximately 620 acres of irrigated and potentially irrigable land on the south side of the corridor.

Rangeland/Open Space. Native rangeland is a significant land use within the proposed pipeline corridor in the state of Montana, including grasslands of the intermountain valleys, foothills, and plains as well as foothill sage brush. In many areas of eastern Montana water spreading dikes have been constructed to enhance forage production.

Forest/Woodland. Forested land is a significant land use within the proposed pipeline corridor only in western Montana. Forested land is also used for livestock grazing during the summer months. Within the corridor approximately half of the forest land indicated is considered commercial timberland.

North Dakota

Table 2.1-81 below summarizes land uses by miles of proposed pipeline.

TABLE 2.1-81 NORTH DAKOTA--LAND USE BY MILES OF PROPOSED PIPELINE

County	Miles	Urban	Agriculture	Rangeland/ Open Space	Forest/ Woodland	Other1/
Williams	61	0	39.1	21.7	0	0.2
Mountrail	42	0	21.4	20.0	0	0.6
Ward	42	0	33.6	6.4	0	2.0
McHenry	37	1.3	10.4	19.2	0	6.1
Pierce	18	0	6.8	10.2	0	1.0
Benson	31	0.3	9.6	17.1	0	4.0
Ramsey	41	0.9	23.6	8.8	0	7.7
Nelson	26	0	19.3	2.3	0	4.4
Grand Forks	44	0	34.5	0	3.5	6.0
Total	342	2.5	198.3	105.7	3.5	32.0

1/ Includes vacant land, water, and water-related areas.

Urban. As shown in table 2.1-82, the proposed pipeline corridor includes numerous small urban areas.

Agricultural. Agricultural land use occurs on almost 70 percent of the land along the proposed pipeline route. Major crops grown are cereal crops (wheat, oats, and barley). In addition, improved pasturelands and haylands related to livestock production are commonly encountered along the route.

Agricultural conservation practices include shelterbelt plantings, strip cropping, grass waterways, and farm ponds.

Rangeland/Open Space. Rangelands occur within the proposed corridor primarily in western North Dakota, although some areas of rangeland are found within the corridor in each of the affected counties. These are generally grasslands with gently rolling topography and silty or saline soils.

Forest/Woodland. Except for a few hardwood draws, wooded areas along river channels, and the numerous shelterbelt plantings mentioned above, the corridor does not cross any wooded areas. Hardwood draws and woodlands are considered avoidance areas under North Dakota's transmission facility siting criteria.

TABLE 2.1-82 NORTH DAKOTA--CITIES, TOWNS, RURAL CENTERS WITHIN CORRIDOR

County	Name	Population1/	Location of Corridor Centerline
Williams	West Williston	NA	1 mile northwest
	Williston	11,364	Adjacent north
	Spring Brook	16	3/4 mile north
	Epping	128	1/4 mile south
	Wheelock	32	3/4 mile south
Montrail	Ross	126	3/4 mile south
	Stanley	1,831	1 mile south
	Blaisdell	NA	1 mile south
Ward	Berthold	356	Adjacent
	Burlington	512	1 mile north
	Minot	32,790	1 mile north
McHenry	Denbigh	142	Adjacent
	Towner	955	Adjacent
	Berwick	32	Adjacent
Pierce	Rugby	3,270	Adjacent
Benson	Pleasant Lake	131	Adjacent
	Knox	109	Adjacent
	York	113	1/4 mile north
	Leeds	632	Adjacent on north
Ramsey	Churchs Ferry	124	Adjacent north
	Penn	NA	Adjacent
	Devils Lake	7,391	1 1/2 miles northeast
	Crary	114	Adjacent
	Doyon	NA	Adjacent
	Bartlett	3	Adjacent on North
Nelson	Lakota	1,214	Adjacent on north
	Mapes	NA	Adjacent
	Michigan	161	Adjacent
	Petersburg	97	Adjacent
Grand Forks	Niagara	111	Adjacent on north
	Arvilla	151	Adjacent
	Emerado	712	1 mile south
	Grand Forks	41,909	2 1/2 miles south

1/ U.S. Department of Commerce, Bureau of the Census 1977
NA = not available

Minnesota

Table 2.1-83 indicates the land uses encountered by the proposed pipeline corridor.

TABLE 2.1-83 MINNESOTA—LAND USE BY MILES OF PROPOSED PIPELINE

County	Miles	Urban	Agriculture	Rangeland/ Open Space	Forest/ Woodland	Other1/
Polk	54	0	48.0	0	2.1	3.9
Red Lake	13	0	11.5	0.5	0	1.0
Clearwater	8	0	5.3	0	1.2	1.5
Total	75	0	64.8	0.5	3.3	6.4

1/ Includes vacant land, water, and water-related areas.

Urban. As shown in table 2.1-84, the proposed corridor would not cross any urban land use in Minnesota.

Agricultural. Agriculture is the predominate land use within the proposed pipeline corridor. From the Red River to the area near Crookston (pipeline mile 1,416 to 1,450), wheat and barley are the dominant crops, with sugar beets also grown. From Crookston east to the terminus, oats and hay become the principal crops; cultivated areas are interspersed with wooded lands.

Rangeland/Open Space. Native rangelands are not a significant land use within the corridor. There are open lands and marshes between cultivated fields and forest covered areas.

Forest/Woodland. From east of Marcoux Corners near pipeline mile 1530 to the Clearbrook Terminus the corridor would cross increasingly forested land interspersed with lakes, marshes, and cultivated lands. Small areas of woodland are also encountered along the Red River and Red Lake River channels.

TABLE 2.1-84 MINNESOTA—CITIES, TOWNS, RURAL CENTERS WITHIN CORRIDOR

County	Name	Population	Location of Corridor Centerline
Polk	East Grand Forks	8,631	4 miles south
	Crookston	8,379	1 mile north
	Gentilly	N/A	3/4 mile north
Clearwater	Clearbrook	596	Adjacent on southwest

Source: SRI International 1978

Special Management Areas

This subsection describes lands with special management concerns located along the proposed pipeline corridors.

Native American Areas

Established Indian Reservations are shown in the Map Addendum. The proposed pipeline would not cross or be adjacent to any Indian Reservations in Washington. As indicated previously, Native Americans of the Pacific Northwest Region also have fishing rights in areas outside of reservations.

In Benewah and Kootenai Counties, Idaho, the proposed pipeline corridor would cross the Coeur d'Alene Indian Reservation for 26 miles (pipeline mile 367 to 393). Within the reservation there is non-Native American-owned lands, Indian allotments, and tribal-owned lands. Significant land uses within the corridor include highly productive wheatlands and forest land.

In North Dakota, near Devil's Lake, (pipeline mile 1331) the proposed pipeline corridor is located about 4 miles northeast of the Fort Totten Indian Reservation.

The proposed pipeline corridor would not cross any Native American areas in Minnesota. The Red Lake Indian Reservation is located about eight miles north of the Clearbrook delivery facility and the Clearwater County road map shows a detached 40-acre portion of the reservation located about 2 miles southeast of the delivery facility.

Natural and Scientific Areas

These are areas in which natural features are preserved for scientific or educational purposes. They are called research natural areas, nature reserves, range reference areas or natural areas, and may be established under federal, state or private authority.

The Washington State Marine Atlas references numerous sites on Hood Canal and southern Puget Sound that are used for scientific research. These areas are illustrated in the Map Addendum.

In Island and Snohomish counties, Washington, the pipeline corridor is adjacent to a scientific research site at Port Susan.

In Grant County, Washington near pipeline mile 226, the corridor is .5 miles west of the Quincy scabland, which has been nominated to the National Register of Natural Landmarks.

Under provisions of the Montana Natural Areas Act of 1974, areas of state-owned land may be nominated for a natural area status in order to provide protection to their unique resources. As of February 28, 1978, none of the 20 areas nominated were within the proposed corridor.

In many locales, but particularly within the rangelands of Montana, nearly pristine or relic vegetative communities have been identified and inventoried by the Soil Conservation Service. The acreage of each site is small, and protection is afforded through cooperation of the landowner. Only one such site, near pipeline mile 1117 in Richland County, is known to be within the proposed pipeline corridor.

Within all of the states except Idaho the proposed corridor is near wildlife areas and refuges under state or federal administration. The U.S. Fish and Wildlife Service, pursuant to the Migratory Bird Conservation Act of 1929, as amended, has acquired by fee or easement large areas of wetlands within the corridor. Management of these areas and their locations are further discussed in the wildlife section.

In North Dakota, several natural areas or potential natural areas are within the corridor; these are indicated on the route maps. Also, the corridor crosses the Oakville Prairie in Grand Forks County. This natural area is leased by the University of North Dakota and is used as a research area.

Wilderness

The proposed pipeline corridor does not cross any U.S. Forest Service RARE-II Study areas recommended for wilderness designation or allocated for further planning. In Washington, crossing the Cascades at Snoqualmie Pass, the proposed pipeline corridor comes within two miles of the Alpine Lakes Wilderness area administered by the U.S. Forest Service.

No wilderness or potential wilderness areas are encountered in Idaho. In Montana the pipeline corridor comes within two to five miles of three U. S. Forest Service RARE-II areas that have been recommended for futher study and planning. These areas are the Rattle Snake area (I-801) in Lolo National Forest north of Missoula; Bullock Hill/Casey Peak area (I-620) in the Helena National Forest southeast of Helena; and the Greenpole Canyon/Halfmoon/Snowies area (I-739) in the Lewis and Clark National Forest in central Montana.

The pipeline corridor comes within one to two miles of three Bureau of Land Management study areas in Montana. These areas are the Wales Creek area (150) west of Helmville, the Hoodoo area (151) southeast of Helmville, and the Woody Flat Creek area (665) in eastern Garfield County.

Land Use Plans and Zoning

Local land use plans often describe policies and goals. Seldom do they specifically address utility corridors. Zoning resolutions generally allow utilities in most zoning categories either by right or through a permitting process. It is therefore often a matter of interpretation whether a particular action would be consistent with existing plans and regulations. Local entities with land use plans and zoning applicable to the proposed pipeline are identified in chapter 1, table 1.6-1.

Within the state of Washington, the Energy Facility Site Evaluation Council (EFSEC) originally determined the proposed pipeline would be consistent with applicable plans and zoning. Due to the cross-sound route change, EFSEC has determined that additional hearings need to be held in Clallam, Island, Snohomish, and King Counties, Washington. Their findings, however, did not encompass regulations contained in County Shoreline Master Programs, a determination to be made later in the review process.

In Idaho, Montana, North Dakota, and Minnesota, where zoning controls are in effect (see table 1.6-1), local (or state in the case of North Dakota) permitting processes would determine if the proposed pipeline is consistent with existing ordinances.

Where the pipeline corridor would cross Federal lands in Washington, Idaho, and Montana as indicated in table 1.2-4, it would be subject to U.S. Forest Service or BLM land management plans. These plans generally require that linear rights-of-way follow existing corridors whenever feasible. Additionally, they contain provisions designed for resource protection.

Bureau of Land Management

Typical of range country from the Musselshell River in Montana to the Williston-Ray area in North Dakota.

Bureau of Land Management

TRANSPORTATION AND UTILITY NETWORKS

Transportation and utility networks and related facilities to be described are inland waterways, highways, railroads, airports, electric transmission lines, communications installations, and pipelines not affiliated with NTPC.

Inland Water Transportation

The proposed pipeline crosses several waterways including Admiralty Inlet, Saratoga Passage, and several streams. A substantial amount of commercial vessel traffic utilizes Admiralty Inlet and Saratoga Passage, however, water transportation near the proposed river crossings is limited to recreation related traffic.

Road and Highway Networks

The proposed pipeline would cross approximately 102 interstate and other primary highways. These highways are shown on the alignment sheets in the Map Addendum.

In the Puget Sound lowlands (to about pipeline mile 125), the roads follow a modified grid pattern. Across the Cascade Mountains the road network is minimal. On the Columbia Plateau, secondary roads are county roads serving an agricultural region and following a rectangular grid survey pattern. From pipeline mile 300 in eastern Washington across the Rocky Mountains to east of Helena, Montana (about pipeline mile 690), the few roads follow an irregular pattern largely constrained by the topography. There is a sparsely developed minor road network across eastern Montana, while in North Dakota and Minnesota there is generally a well developed pattern of county roads following township and section lines.

As can be seen on the alignment sheets (Map Addendum) much of the pipeline route is roughly parallel to and close to major highways. The many small towns along these highways are connected to outlying areas by county roads which would be crossed by the pipeline. In some areas, such as Idaho and western Montana there are only a limited number of such roads and often no reasonable alternative routes for reaching the towns. The more numerous roads in the nonmountainous and populated areas generally provide reasonable alternative connections between places. The county roads near towns and the numerous other municipal streets and roads which would be crossed when the pipeline skirts larger towns carry a substantial amount of local traffic.

The existing network of Federal and state highways, paved and unpaved county roads, unimproved roads, and other utility access roads would provide access to the pipeline corridor along the entire route. Along most of the route, away from towns and cities, these access roads carry low volumes of traffic.

Railroads

Sixty major railroads would be crossed or paralleled by the proposed pipeline. There may be a limited number of additional crossings of spur lines and unidentified private rail lines. The pipeline route would parallel 62 miles of railroad right-of-way.

Airports

Forty various commercial airports, military air bases, and other airfields are located along the proposed pipeline route. There may be additional small landing strips along the route.

Electric Transmission Lines

Approximately 100 major transmission lines would be crossed or paralleled by the proposed route. The pipeline route would parallel 156 miles of powerline right-of-way. Where the proposed pipeline route parallels a powerline any crossings that might occur would not be determined until final survey and design were completed. In urbanized areas many local power distribution lines would be crossed by the pipeline. The location of such crossings would not be known until obtained from local utility offices at the time of detailed route surveys. In rural areas there would be many crossings of distribution lines that frequently parallel roads along township and section lines. The location of these crossings would also be determined when route surveys were carried out.

In Minnesota the Northern States Power Company is studying a 20-mile wide corridor for selection of a route for a proposed 500-kV transmission line. This study corridor would be crossed by the proposed NTPC route (pipeline miles 1422 to 1442).

The U.S. Department ot the Interior has issued a draft environmental statement (January 1979) on the proposed Colstrip Project, including possible transmission line coridors in Montana. Depending upon the transmission line corridor used, the NTPC could parallel or cross the Colstrip corridor from Plains, Montana (pipeline mile 490) to east of Harlowton, Montana (pipeline mile 786).

Communications

In urbanized areas there would be many crossings and much construction parallel with underground and overhead communication lines including telephone and cable TV. The exact number and location of these facilities would not be known until final survey and design were completed.

Outside of urban areas the proposed pipeline parallels an American Telephone and Telegraph cable operated by Pacific Northwest Bell through Snoqualmie Pass. In North Dakota there would be numerous cable crossings at a military installation.

Unaffiliated Pipelines

Various types of pipelines would be crossed or paralleled along the proposed NTPC route. The route would parallel 286 miles of existing pipeline routes. When a shared route is narrow and constricted by topography there might have to be multiple line crossings which cannot be precisely located at this time. In local urbanized areas, many natural gas, water, sewer, and storm sewer pipelines would be crossed by the proposed NTPC pipeline. The locations of these smaller local pipelines would be obtained from the local private and municipal utility offices at the time of detailed land surveys.

The following narrative is divided into three segments based on the presence of similar recreational opportunities.

Recreational sites and areas within 2 miles of the proposed corridor are shown in the Map Addendum.

Green Point, Washington to Arlington, Washington (pipeline mile 0 to 69)

Tourism is a major industry in this area of the northwest and depends on islands, coastline, clean waters, and air of Puget Sound and the Strait of Juan de Fuca, as well as two major national parks and a large metropolitan area. A network of state-owned ferries which traverse beyween the islands in central Puget Sound are heavily used in the summer months. Amount of use is unassessable.

Sport fishing for salmon and bottomfish is concentrated off Port Townsend and between Whidbey and Camano Islands in Puget Sound. Recreational shellfish areas are found on Dungeness Spit, Sequim Bay between Quimper Peninsula and Indian Island, Admiralty Inlet, Saratoga Passage, Skagit Bay, and Port Susan. The area averages 216,000 recreational trips per year (based on a 1976-1977 average). Saratoga Passage had 120,000 user trips. Admiralty Inlet from Dungeness Spit to Port Townsend had 62,000 and 34,000 user trips respectively (Washington Department of Fisheries, pers. comm. 1979).

Shoreline park areas along the Strait and central Puget Sound area which have intensive use and which could be severely affected by a pipeline rupture are listed in table 2.1-85.

TABLE 2.1-85 SHORELINE PARK AREAS

Area	1978 Number of Visits
Dungeness National Wildlife Refuge and Recreation Area	115,000
Seqim Bay State Park	865,185
Fort Worden State Park	910,981
Old Fort Townsend State Park	237,228
Fort Flagger State Park	492,100
South Whidbey Island State Park	106,171
Fort Casey State Park	444,612
Deception Pass State Park	2,143,236
James Island State Park	16,211
Spencer Spit State Park	42,247
Skagit Wildlife Recreation Area	73,449

According to the Washington State Department of Recreation, approximately 70 percent of day use and 53 percent of overnight camping occurs during June through August. Total use of the shoreline parks was more than 5 million visits in 1979. However, state shoreline park usage figures represent a small portion of total use of the Sound (Department of Recreation, pers. comm. 1979). Summer daily use of boat launch and moorage facilities as well as pleasure boating and use of county and local parks is thought to be significantly higher than state shoreline park use.

Shoreline parks on the mainland side of Puget Sound also receive heavy year round use. The Skagit Wildlife Recreation Area, a 13,000 acre area with the largest concentration of Snow Geese in the northwest, occupies a large portion of Skagit Bay and part of Port Susan in the Stanwood area. Hunting as well as wildlife-related forms of nonconsumptive recreation attracted over 70,000 recreationists in 1978. Due to the proximity of the Skagit Wildlife Recreation area the Washington Shorelines Management Act of 1971 designated the northernmost shoreline of Camano Island and the northeastern shoreline of Whidbey Island as shorelines of statewide significance.

Arlington, Washington to Canyon Ferry Reservoir, Montana (pipeline mile 69 to 690)

Recreation east of the Sound to the Canyon Ferry Reservoir in Montana is mainly oriented to use of forested areas and river corridors.

The Snoqualmie River corridor between the towns of Snoqualmie and Tanner, 3 miles north of pipeline mile 122 to 127, is considered by the Washington State Highway Department to have unique recreational value. South of Interstate 90, many as yet undeveloped areas are considered to have high recreation potential.

The Snoqualmie Pass area (pipeline mile 142 to 147) experiences heavy use throughout the year. Alpine and Nordic skiing areas, designated and groomed snowmobile trails, hiking on historic and nature trails, horseback riding, camping, fishing, hunting, picnicking, and other day uses, are examples of the diverse recreation in the area. The Pacific Crest Trail (PCT) is crossed at pipeline mile 145. Snoqualmie Pass is a major trailhead for access to the PCT. The PCT is one of a few trails identified as having National Scenic Trail status. The nearby Asahel Curtis Recreation Area was designated in 1949 to preserve the largest grove of virgin growth Douglas-fir trees in the area. A nature trail and picnic facilities would be crossed at pipeline mile 143.

Estimated cross country skiing and snowmobile use in the Surveyor Hyak Lakes vicinity (pipeline mile 143) was 150,000 in 1978 (U.S. Forest Service pers. comm. 1978). Other important uses in the Pass are big game hunting and off-road vehicle (ORV) use. Portions of the existing transmission line corridor receive heavy dirt bike use (U.S. Forest Service 1978).

East of Snoqualmie Pass, the proposed line follows Keechelus Lake, and passes a few miles south of Kachess and Cle Elum Lakes. There is developed and dispersed recreational activity near the main highway as well as around the lakes. High quality recreational home development is occurring around portions of Keechelus and Kachess Lakes.

East of Plains, big game hunting and fishing dominate recreational pursuits. Hunting for moose, deer, and elk occurs throughout the area. Fishing pressures along Nine-Mile Creek and its tributaries was 1,150 man-days in 1977 (Montana Department of Game 1978).

The Lewis and Clark National Historic Trail parallels the Blackfoot River and is crossed along this portion of the route (pipeline mile 566). Many boaters float this segment of the river, although upstream portions are more popular.

The recently designated Continental Divide National Scenic Trail follows the Continental Divide. This portion of the trail is noted for the high scenic and historic values experienced in the area. The proposed pipeline would cross the trail at pipeline mile 640.

Historic mining towns, spectacular mountain scenery, and the western appeal of Helena combine to draw tourists and recreationists to this area. The nearby Canyon Ferry Reservoir is popular for day and overnight uses. Power boating, fishing, and other water activities occur on the Reservoir. Big game and waterfowl hunting add to the recreational attractiveness of the area. Following the Missouri River, the Lewis and Clark Historic Trail is again crossed, just west of Townsend. Good fishing in the Missouri River is locally attractive. Float boating from Toston to the bridge outside of Townsend is locally attractive (pipeline mile 690) (see Map Addendum) for locations of all areas within the corridor). Some winter ice fishing occurs on the Reservoir, however, most Reservoir use is seasonal and related to boating or fishing activities.

Canyon Ferry Reservoir, Montana to Clearbrook, Minnesota (pipeline mile 690 to 1491)

East of the Canyon Ferry Reservoir recreation is primarily hunting, fishing or nonconsumptive wildlife related with few well definable recreation areas. Much of the region is rural and only small portions are forested.

The Smith River is becoming locally popular for float boating, fishing, and camping. A stretch of the Smith River approximately 15 to 20 miles downstream from pipeline mile 730 is proposed for designation as a State Recreational Waterway; it is also being considered as a candidate for Federal Wild and Scenic River status (Montana Department of Fish and Game 1978).

East of Harlowton, some fishing and water related recreation occurs at the Martinsdale Reservoir (pipeline mile 755) and the Charles M. Russell National Wildlife Refuge (pipeline mile 1029-1041).

Tourist stops at historic Fort Union and Fort Buford near the Montana-North Dakota border are increasing. Attendance at Fort Buford in 1977 was 4,370 (State Historical Society 1978).

Again, trails of historic significance are crossed. The Lewis and Clark National Historic Trail along the Missouri River is crossed at pipeline mile 1135. Near Harlowton (pipeline mile 845) the Nez Perce Trail is currently under study for federal status.

Eastern Montana recreationists favor dispersed, consumptive forms of recreation. White-tailed deer and antelope are hunted throughout the area, although upland game hunting for pheasants and grouse is apparently more popular. Driving for pleasure, rock hounding, fishing, off-road recreational vehicle use, cross country skiing and snowshoeing, and wildlife viewing are popular leisure activities.

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Recreation in North Dakota tends to be dispersed and of local interest. Large and small game are hunted throughout the area. A 200-mile-long waterfowl production corridor known as the Prairie Pothole Region (from Minot to East Grand Forks) is part of a migratory bird flyway and supplies waterfowl for hunters in other areas of the United States as well as North Dakota. Wildlife refuges in the area are not open for public or recreational uses. Two game management areas, Knox Slough (pipeline mile 1,281) and Crary Game Management area (pipeline mile 1,335), are within the 2-mile corridor. Although the refuges are closed to hunters, a significant amount of hunting does occur along refuge boundaries (referred to as "line hunting"). The Devils Lake Wildlife Management District had over 6,000 visits for hunting migratory birds between August 1977 and July 1978 (as compared to 435 visits for hunting upland game birds and 385 visits for hunting big game). Approximately 240,000 visits for consumptive and nonconsumptive forms of recreation occurred during that time period (North Dakota Fish and Wildlife Service, pers. comm. 1978).

The Devils Lake Recreational Area (pipeline mile 1,390), of local importance is a few miles south of the town of Devil's Lake. The nearby Sully's Hill Game Reserve experiences heavy day use. Annual use averages 100,000 visitors.

Fishing for northern pike and walleye occurs on the Little Muddy, White Earth, Souris, Turtle, and Red Rivers. Access to these rivers is in general available in more than the specific corridor area.

Canoeing on the Red Lake River, a state designated canoeing route, is locally popular in Minnesota. Scattered small lakes in western Minnesota provide many opportunities for water-related activities. Big game hunting along streams or in fields occurs throughout the area. For locations of all areas within the proposed corridor, see the Map Addendum.

TABLE 2.1-86 SIGNIFICANT RECREATION AREAS ALONG THE PROPOSED PIPELINE CORRIDOR

Name	County	Location Pipeline Mile	T-R	W/1mi	W/2mi	Relationship Shoreline Downstream	Use	Comment
WASHINGTON								
Dungeness Wildlife Refuge Voice of America County Park Dungeness State Park	Clallam	5	T31N R4W			Shoreline and downstream	115,000 visitors	1978 use for combination of three areas
Port Williams	Clallam	11	T30N R3W	x				Boat launch only
Port Townsend	Jefferson	24	T30N R2W			Shoreline		Historic town considered tourist attraction to area
Fort Ebbey State Park	Island	29	T32N R1W	x		Shoreline		Recently established park
Tidelands with public access	Island	30-36		x		Shoreline		Beach and tideland area
Whidbey Island	Island	29-45		x		Shoreline		Entire island has high tourism, recreational values.
Arrowhead Beach--tidelands	Island	50	T32N R3E					
Skagit Wildlife Recreation Area	Skagit	55	T32N R3E T23N R8E	x		Shoreline and downstream (from Stillaguamish River)		Wildlife values
Snoqualmie River Corridor	King	121-126		x		Downstream		High recreational potential, high scenic values
Ollalie State Park	King	130-131		x				Recently established park, includes original Twin Falls State Park.
Asahel Curtis Natural Area	King	143	T22N R10E	x			700 visitor use days	Preserved grove of Douglas-fir and nature trail
Keechelus	Kittitas	147	R22N R11E	x		Downstream		Public fishing
Lake Easton State Park	Kittitas	160	T20N R13E	x		Downstream	222,903 visitors	1978 figures for day and overnight use of park.
Recreational home development	Kittitas			x	x			High value homes purchased for scenic values and solitude in area.
Clockum Wildlife Recreation area	Kittitas, Grant			x			111,201 visitor use days	1978 use for all types of recreation; important for wildlife related values
Gloyd Seeps Wildlife Recreation Area	Grant			x				Wildlife related values
Oasis Park	Grant	246	T21N R26E	x				City park with camping and day use
IDAHO								
Heyburn State Park	Beneuah	380	T46W R3W	x				
Benewah Lake	Benewah	384	T46N R3W	x				Wildlife related values
St. Joe River	Benewah	385	T46N R2W	x				Fishing and scenic river values.
IDAHO (continued)								
Cataldo Mission	Kootenai	410	T49N R1E	x				Historic site
MONTANA								
Clark Fork River Corridor	Sanders, Missoula	463-500		x		Downstream		Variety of river related uses, high scenic values
Camp Grand Menard	Missoula	526	T15N R22W	x				Day use area
Lewis and Clark National Historic Trail	Missoula	554	T13N	x				
Nevada Creek Reservoir	Powell	613	T12N R10W	x				Swimming, fishing, boating
Continental Divide National Scenic Trail	Powell	640	T11N R6W	x				
Fort William Henry Harrison	Lewis and Clark		T10N R4W	x				
Helena	Lewis and Clark	658	T10N R3W	x				Historic character of area attractive to tourism
Canyon Ferry Reservoir	Broadwater	690	T7N R2N	x		Downstream		High recreation and wildlife related values
Lewis and Clark National Historic Trail and Missouri River use	Broadwater	690	T7N R2E	x		Downstream		
Lake Mason National Wildlife Refuge	Musselshell	826	T11N R23E	x				Wildlife related recreational values
Charles M. Russell National Wildlife Refuge	Garfield	955	T19N R42E	x				Wildlife relation recreational values
Lewis and Clark National Historic Trail	Roosevelt	1071	T26N R59E	x				
NORTH DAKOTA								
Palermo State Game Management area	Mountrail	1162	T156N R90W	x				Wildlife related recreational values
Mouse River State Rorest Recreation area	McHenry	1250	T156N R76W	x				Campground, day use area
Pleasant Lake National Wildlife Refuge	Benson	1278	T156N R71W	x				Wildlife related recreational values
Silverlake National Wildlife Refuge	Benson	1306	T156N R67W	x				Wildlife related recreational values
Sully's Hill National Game Preserve	Ramsey	1323	T154W R64W			vicinity	100,000 1977	Wildlife related recreational values visitors
Crary State Game Management Area	Ramsey	1335	T153N R63W		x			Wildlife related recreational values
Prairie Pothole Area	Ward, McHenry, Pierce, Benson, Ramsey, Nelson, Grand Forks	1207-1410		x		vicinity		Waterfowl production area for North Dakota and rest of U.S. Important wildlife vaues for consumptive and nonconsumptive recreation.
Turtle River State Park	Grand Forks	1391	T152N R54W	x			157,727 1977 visitors	Only state park in area

ECONOMIC CONDITIONS

Population

Populations for the counties adjacent to the proposed route are listed in table 2.1-88 in the following section. Table 2.1-87 presents county economic profiles. See Map Addendum for the relative population density of the counties. Population centers near the proposed route are shown in figure 2.1-21. Construction sections which would determine related impacts of the proposal are shown in the Map Addendum.

Land along the proposed route is generally rural. The major urban concentrations include the Seattle-Tacoma area and Spokane in Washington; Coeur d'Alene, Idaho; Missoula, Helena, and Billings in Montana; and Minot and Grand Forks in North Dakota. These cities serve as regional service and trade centers for outlying rural areas.

Personal Income

Personal income varies widely among counties in the study area. Average per capita income for each of the five states in 1975 was: Washington $6,284; Idaho, $5,177; Montana, $5,433; North Dakota, $5,781; and Minnesota, $5,817. While a majority of the affected counties had per capita income levels below their respective state average, the most populous counties and certain agricultural areas had above average income levels. In particular, income levels for agricultural counties in eastern Washington, eastern Montana, and eastern North Dakota were above state averages.

Taxes

Total property tax collections are shown in table 2.1-87 and represent the total property tax burden in each county. The Washington sales tax of 4.6 percent would apply to pipeline construction. All counties (or cities) levy an additional tax of 0.5 percent (0.8 percent in several cities) on the same base. Local sales tax collections, however, may be affected by whether the tax is imposed at the point-of-use or point-of-sale. In addition, Washington imposes a business and occupation tax of 0.4664 percent applicable to contractor gross income. Both Idaho and North Dakota impose a 3 percent sales tax which applies to construction materials and equipment. Minnesota imposes a 4 percent sales tax on a similar base.

Indian Reservations

Coeur d'Alene Indian Reservation

About 550 Native Americans live on the reservation. Employment conditions are good compared with those on other reservations, but additional job opportunities are sought (SRI International 1978).

Market Area

The potential market area is defined as the northern tier states plus the other states within Petroleum Administration for Defense Districts (PADD) 2 and 4. (See Figure 1 in Introduction). For analytical purposes, Wyoming is included with the northern tier states defined by the Public Utility Regulatory Policies Act of 1978. The other states in PADD 2 and 4 include: Utah, Colorado, South Dakota, Nebraska, Kansas, Oklahoma, Iowa, Missouri, Kentucky and Tennesee. Information for the market

Bureau of Land Management

TABLE 2.1-87 COUNTY ECONOMIC PROFILES

Counties	Employment	Unemployment Rate	Principal Industry	Personal Income (Thousands)	Per capita Income	Total Property Taxes (Thousands)
WASHINGTON	(1976)	(1976)	(1975)	(1975)	(1975)	(1978)
Clallam	15,260	9.1	Forest products	$ 231,164	$ 5,650	$ 11,054
Jefferson	4,000	9.5	Forest products	63,203	5,339	6,155
Kitsap	40,800	8.0	Forest products	690,219	5,922	22,025
Island	9,390	9.3	Government	164,636	4,956	7,663
San Juan	2,160	8.9	Government	34,046	6,284	3,851
Whatcom	37,950	10.0	Forest Products	509,844	5,626	29,473
Skagit	23,760	10.9	Forest Products	343,953	6,277	18,734
Snohomish	104,700	9.2	Forest Products	1,455,111	5,544	67,447
King	564,881	9.0	General mfg.	8,241,962	7,172	354,755
Kittitas	8,670	10.1	Government	116,941	4,601	5,443
Chelan	27,540[1]	9.1[1]	Agriculture	288,905	7,156	12,196
Yakima	61,120	9.1	Agriculture	895,735	5,827	33,320
Douglas	1/	1/	Agriculture	105,129	5,524	5,649
Grant	18,340	8.8	Agriculture	304,930	6,736	13,582
Lincoln	3,880	2.3	Agriculture	70,664	7,306	5,473
Adams	5,540	7.4	Agriculture	134,935	10,391	6,384
Spokane	116,400	7.5	Government	1,718,751	8,637	68,947
Whitman	14,800	3.9	Government	206,437	4,926	12,065
IDAHO	(1977)	(1977)	(1975)	1975)	(1975)	(1977)
Kootenai	19,113	9.5	Forest products	$ 216,866	$ 4,635	$ 12,233
Benewah	2,855	9.9	Forest products	31,651	4,627	1,820
Shoshone	7,293	6.5	Mining	104,092	5,592	6,332
MONTANA	(1977)	(1977)	(1975)	(1975)	(1975)	(1975)
Sanders	4,268	8.4	Forest product	32,406	4,025	2,949
Mineral	1,416	6.6	Government	15,244	4,364	NA
Lake	6,339	6.0	Government	61,917	3,643	5,734
Missoula	32,793	5.7	Government	321,158	4,823	23,961
Granite	1,022	5.8	Government	9,185	3,421	NA
Powell	3,139	4.3	Government	33,249	4,469	2,005
Lewis & Clark	21,260	4.4	Government	213,964	5,797	368
Deer Lodge	6,063	6.6	Government	70,624	4,639	NA
Silver Bow	15,585	7.1	Mining	227,256	5,253	NA
Jefferson	2,629	5.9	Government	25,350	3,497	222
Broadwater	1,410	4.0	Agriculture	12,543	4,437	1,236
Meagher	837	2.4	Agriculture	10,213	4,646	953
Judith Basin	1,278	3.3	Agriculture	16,065	5,902	NA
Wheatland	1,332	3.5	Agriculture	14,023	6,031	981
Fergus	5,527	3.6	Agriculture	70,931	5,515	4,765
Golden Valley	441	4.8	Agriculture	3,738	4,032	632
Petroleum	1,853	5.4	Agriculture	1,682	2,552	361
Musselshell	1,853	5.4	Mining	20,971	5,156	1,944
Yellowstone	50,132	3.9	Government	580,812	5,961	NA
Garfield	877	1.7	Agriculture	12,110	7,738	1,138
McCone	1,527	2.1	Agriculture	21,853	8,142	1,963
Custer	5,730	2.9	Agriculture	63,883	5,313	NA
Roosevelt	5,581	3.9	Agriculture	66,086	6,609	4,603
Richland	5,290	1.8	Agriculture	61,026	6,275	6,015
Dawson	5,458	2.8	Transportation	61,228	5,910	5,251
NORTH DAKOTA	(1976)	(1976)	(1975)	(1975)	(1975)	(1976)
Williams	9,618	4.5	Transportation	95,530	5,096	4,386
Mountrail	3,637	6.6	Agriculture	27,916	3,335	1,682
Ward	24,381	5.5	Government	334,843	5,546	10,709
McHenry	3,332	10.6	Agriculture	39,275	4,530	1,931
Towner	1,163	3.5	Agriculture	32,727	7,865	NA
Pierce	3,214	4.9	Agriculture	31,052	4,691	1,507
Benson	3,080	7.8	Agriculture	45,449	5,453	NA
Ramsey	6,613	5.6	Agriculture	81,936	6,096	3,597
Nelson	2,850	5.2	Agriculture	41,448	7,244	1,666
Grand Forks	28,349	5.2	Government	382,480	6,124	14,137
MINNESOTA	(1976)	(1976)	(1975)	(1975)	(1975)	(1978)
Polk	15,261	5.2	Agriculture	196,880	5,583	10,626
Red Lake	2,044	9.3	Agriculture	26,191	5,070	1,354
Clearwater	3,119	10.6	Government	26,485	3,068	2,188
Beltrami	10,890	6.1	Government	91,921	3,073	NA

Sources: Employment: Compiled by SRI from state employment agency data.
Unemployment rate: Compiled by SRI from state employment agency data.
Principle industry: Compiled from personal income data, BFA, Local Area Personnel Income 1970-1975, 1977
Personal Income: BEA, Local Area Personal Income 1970-1975, 1977.
Per capita income: BEA, Local Area Personal Income 1970-1975, 1977
Property taxes: Furnished by state property tax administration agencies.

1/Data for Chelan County represents combined data for Chelan and Douglas Counties.

2/Represents largest industrial income source other than trade and services, which are considered to be dependent on the local population. Forest products is cited in place of manufacturing where it is the principal manufacturing activity.

TABLE 2.1-88 COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

Washington: County	Type	Land Area (Square Miles) [1]	1977 Population [2]	Density (Persons per square mile) [5]	Annual Growth Rate [1] 1970-1975	Projected Population 2000 [2]	Projected Annual Growth Rate 1977-2000	Medical Facilities[3]			Housing				Service Establishments[7]	Police Protection	
								Hospitals City/Beds	Intensive Care Unit	Number of Personnel	Total Rental Units	Vacancy Rate (Percent)	Transient Accomodations[6]	Camper/Trailer Spaces (Near Pipeline Route)[4]		State	County/Local
lallam	R	1,753	41,100	24	3.54	55,900	0.02	Forks 32 Port Angeles 86	× ×	625 250	4,110	4.4	997	296	425	9	48
efferson	R	1,805	12,600	7	2.20	18,400	0.02	Port Townsend 31	×	68	1,794	2.1	398	174	142	2	22
itsap	U	393	126,300	321	2.92	172,500	0.02	Bremerton— Harrison Mem. 184 Naval Reg. Med. Center 98	 × ×	 480 457	654	3.7	644	0	858	26	129
land	R	2,165	37,528	17	4.60	57,000	0.02	Coupeville 44 Oak Harbor 24	× No	86 147	1,589	5.2	257	29	263		35
kagit	R	11,267	56,000	5	0.92	71,800	0.01	Anacortes 44 Mt. Vernon 127 Sedro Woolley 95	× × ×	104 308 221	3,717	6.8	521	400	658	17	72
nohomish	R	52,689	278,200	5	−0.20	441,300	0.03	Arlington 36 Edmonds 159 Everett 190 188 Monroe 52	× × × × No	69 495 536 534 102	8,997	4.3	1,206	616	2,152		288
ing	U	2,128	1,164,000	547	−0.18	1,551,500	0.01	Auburn 104 Bellevue 177 Enumclaw 38 Kirkland 76 108 Renton 247 Seattle—22 Hospitals—many large	× × × × × ×	278 411 95 277 64 737	88,175	4.2	15,151	432	10,117	131	1,826
ittitas	R	2,317	25,600	11	0.30	28,100	0.004	Ellensburg 50	N/A	N/A	2,731	2.3	521	363	303	22	17
helan	R	2,918	41,900	14	−0.36	50,100	0.008	Chelan 28 Wenatchee 162 23	Coronary Care only × No	43 438 39	2,700	3.0	1,508	150	562	19	75

TABLE 2.1-88 (Continued) COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

								Medical Facilities[3]			Housing					Police Protection	
Washington: County	Type	Land Area (Square Miles)[1]	1977 Population[2]	Density (Persons per square mile)[5]	Annual Growth Rate[1] 1970-1975	Projected Population 2000[2]	Projected Annual Growth Rate 1977-2000	Hospitals City/Beds	Intensive Care Unit	Number of Personnel	Total Rental Units	Vacancy Rate	Transient Accomodations[6]	Camper/Trailer Spaces (Near Pipeline Route)[4]	Service Establishments[7]	State	County/Local
Yakima	R	4,268	155,700	37	1.18	191,100	0.01	Sunnyside 41 38 Toppenish 63 Yakima 28 218 211	No × × × × ×	N/A 212 183 65 575 603	197	N/A	44,723	544	1,555	38	234
Grant	R	2,675	45,500	17	1.62	59,600	0.01	Ephrata 58 (29 long-term) Grand Coulee 46 Moses Lake 50 Quincy 16 Soap Lake 42	× No × × No	67 53 116 28 N/A	5,456	3.6	1,367	450	511	5	65
Lincoln	R	2,306	9,800	4	0.20	10,000	0.001	Davenport 93 (69 long-term) Odessa 44	No No	88 38	82	N/A	114	141	133	2	39
Adams	R	1,894	13,900	7	1.62	17,900	0.01	Othello 46 Ritzville 20	No No	81 35	N/A	N/A	393	45	139	9	20
Spokane	S/U	1,758	308,200	175	1.22	376,700	0.01	Deer Park 26 Fairchild AFB 45 Medical Lake 395 Spokane—8 Hospitals—many large	N/A ×	N/A 311 477	N/A	N/A	4,356	353	2,554	51	407
Whitman	R	2,153	41,900	20	2.12	49,500	0.01	Colfax 58	No	78	N/A	N/A	230	N/A	280	7	14
Whatcom	R	21,512	93,600	4	2.10	133,600	0.02	Bellingham— St. Joseph 103 St. Lukes 112	 × ×	 263 264	7,709	3.7	1,314	635	894	10	110
Douglas	R	1,267	20,100	16	2.68	27,000	0.02	N/A	N/A	N/A	N/A	N/A	271	N/A	126	19	23

TABLE 2.1-88 (Continued) COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

								Medical Facilities[3]			Housing					Police Protection	
Idaho: County	Type	Land Area (Square Miles)[1]	1977 Population[2]	Density (Persons per square mile)[5]	Annual Growth Rate[1] 1970-75	Projected Population 2000[2]	Projected Annual Growth Rate 1977-2000	Hospitals City/Beds	Intensive Care Unit	Number of Personnel	Total Rental Units	Vacancy Rate (Percent)	Transient Accomodations[6]	Camper/Trailer Spaces (Near Pipeline Route)[4]	Service Establishments[7]	State	County/Local
Kootenai	R	1,249	46,481	37	6.48	80,900	0.03	Coeur d'Alene 181	×	345	2,315	4.2	850	174	522 (5-county area)	25	66
Benewah	R	788	7,019	9	1.96	11,500	0.03	St. Maries 35	Cardiac Care only	45	2,360	1.7	41	22	99 (5-county area)	25	10
Shoshone	R	2,609	19,078	7	−1.12	18,900	−0.0004	Kellogg 56 Silverton 40	× ×	80 60	1,012	9.9	70	114	245 (5-county area)	25	28

TABLE 2.1-88 (Continued) COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

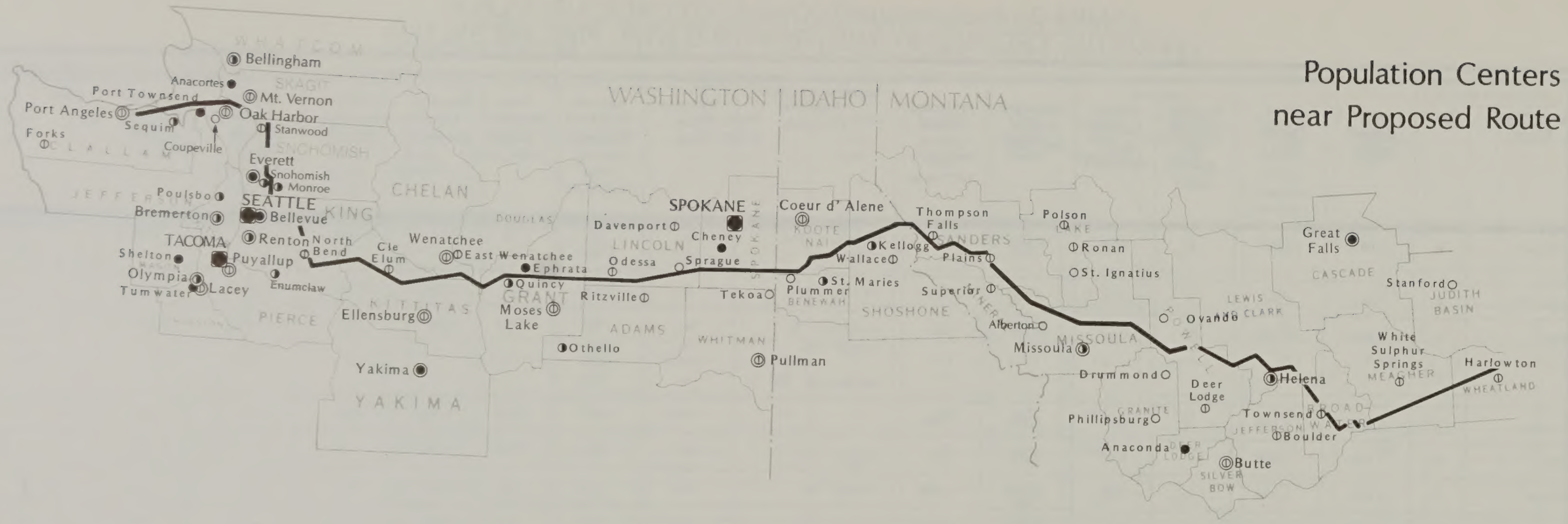
Montana: County	Type	Land Area (Square Miles)[1]	1977 Population[2]	Density (Persons per square mile)[5]	Annual Growth Rate[1] 1970-1975	Projected Population 2000[2]	Projected Annual Growth Rate 1977-2000	Medical Facilities[1]			Housing				Service Establishments	Police Protection	
								Hospitals City/Beds	Intensive Care Unit	Number of Personnel	Total Rental Units	Vacancy Rate (Percent)	Transient Accomodations[6]	Camper/Trailer Spaces (Near Pipeline Route)[3]		State	County/Local
Sanders	R	2,778	8,063	3	2.70	13,000	0.03	Plains 32	×	50	N/A	N/A	115	231	101	1	8
Mineral	R	1,222	3,499	3	3.62	6,100	0.03	—	—	—	N/A	N/A	100	171	65	2	8
Lake	R	1,494	17,086	11	3.52			Polson 40 Ronge 27 St. Ignatius 30	× No ×	52 25 39	N/A	N/A	N/A	1,167	211	5	10
Missoula	R	2,612	65,090	25	2.86	100,100	0.02	Missoula 115 57 207	× × ×	298 86 539	2,736	2.2	1,073	921	649	14	94
Granite	R	1,733	2,729	2	−0.38	3,100	0.006	Philipsburg 10	No	16	N/A	18.9	N/A	440	52	2	3
Powell	R	2,336	7,569	3	2.34	12,300	0.03	Deer Lodge 35	No	56	501	1.0	124	375	79	2	8
Deer Lodge	R	740	15,101	20	−0.54	16,600	0.004	Anaconda 128 Galen 180 Warm Spring 715	× No No	140 257 684	N/A	11.3	176	145	139	2	24
Silver Bow	S/U	715	43,034	60	0.60	48,100	0.005	Butte 140 180	× ×	209 452	3,098	2.2	850	38	506	7	70
Jefferson	R	1,652	6,839	4	7.68	11,000	0.03	—	—	—	N/A	5.4	N/A	135	66	3	7
Lewis & Clark	R	3,476	36,822	11	2.18	66,900	0.04	Ft. Harrison VA 160 Helena 35 144	× No ×	296 63 322	4,299	3.0	1,114	680	419	8	49
Broadwater	R	1,193	2,838	2	2.92	4,800	0.03	Townsend 21	No	25	N/A	N/A	28	49	43	2	5
Cascade	R	2,661	83,832	32	0.70			Great Falls 213 372 Malmstrom AFB 20	× × No	694 686 209	N/A	N/A	N/A	232	822	N/A	N/A
Meagher	R	2,354	2,283	1	0.72	2,300	0.003	White Sulpher Springs 8	No	N/A	N/A	N/A	32	131	43	1	3
Judith Basin	R	1,880	2,670	1	0.42	2,900	0.004	—	—	—	N/A	N/A	N/A	33	48	1	4
Wheatland	R	1,420	2,419	2	−1.62	1,800	−0.01	Harlowtown 23	No	42	48	3.0	70	20	41	1	3
Fergus	R	4,242	12,925	3	0.40	14,700	0.006	Lewistown 50	×	139	745	24.0	290	83	183	6	21

TABLE 2.1-88 (Continued) COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

Montana: County	Type	Land Area (Square Miles)[1]	1977 Population[2]	Density (Persons per square mile)[5]	Annual Growth Rate[1] 1970-1975	Projected Population 2000[2]	Projected Annual Growth Rate 1977-2000	Medical Facilities[1]			Housing				Service Establishments	Police Protection	
								Hospitals City/Beds	Intensive Care Unit	Number of Personnel	Total Rental Units	Vacancy Rate (Percent)	Transient Accomodations[6]	Camper/Trailer Spaces (Near Pipeline Route)[4]		State	County/Local
olden Valley	R	1,176	927	1	−0.08	1,000	0.003	—	—	—	N/A	N/A	N/A	1,063	17	1	1
etroleum	R	1,655	659	(z)	−0.48	700	0.003	—	—	—	N/A	N/A	N/A	0	14	1	2
Iusselshell	R	1,887	4,202	2	1.78	6,300	0.02	—	—	—	1-2	N/A	90	0	71	1	11
ellowstone	R	2,642	97,220	37	2.30	181,000	0.04	Billings 197 227	× ×	561 718	9,927	1.2	N/A	313	1,028	19	142
arfield	R	4,455	1,781	(z)	−2.58	2,000	0.005	Jordan 20	×	20	N/A	18.2	N/A	58	21	1	2
oosevelt	R	2,385	10,325	4	−0.70	12,900	0.01	Culberston 59 Poplar 22	× No	96 59	N/A	10.1	N/A	248	148	4	10
cCone	R	2,607	2,709	1	−1.32	2,800	0.001	—	—	—	N/A	2.5	N/A	0	31	1	2
ichland	R	2,079	9,929	5	−0.22	14,400	0.02	—	—	—	N/A	7.1	N/A	35	126	2	8
awson	R	2,370	10,725	5	−1.62	15,700	0.02	Glendive 46	×	95	2,200	6.8	118	235	123	7	16
rairie		1,730	1,861	1	1.52			Terry 20	×	27	381	11.8	N/A	N/A	31	N/A	N/A

TABLE 2.1-88 (Continued) COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

North Dakota: County	Type	Land Area (Square Miles)[1]	1977 Population[2]	Density (Persons per square mile)[5]	Annual Growth Rate[1] 1970-1975	Projected Population 2000[2]	Projected Annual Growth Rate 1977-2000	Medical Facilities[3]			Housing				Service Establishments[7]	Police Protection	
								Hospitals City/Beds	Intensive Care Unit	Number of Personnel	Total Rental Units	Vacancy Rate (Percent)	Transient Accomodations[6]	Camper/Trailer Spaces (Near Pipeline Route)[4]		State	County/Local
Williams	R	2,064	18,793	9	−0.58	17,600	−0.003	Williston 110 Tioga 29	× No	261 59	28	N/A	430	175	260	4	36
Mountrail	R	1,819	8,569	5	−0.16	8,500	−0.0004	Stanley 25	×	46	23	N/A	N/A	68	119	1	10
Ward	R	2,044	61,503	30	0.62	80,200	0.01	Kenmore 38 Minot 200 473 Minot AFB 50	No × × ×	29 515 645 330	135	N/A	900	104	487	6	79
McHenry	R	1,879	8,738	5	−0.68	7,100	−0.008	—	—	—	23	N/A	N/A	52	94	1	10
Pierce	R	1,038	6,828	7	0.92	5,200	−0.01	Rugby 153	×	238	15	N/A	63	11	78	1	6
Towner	R	1,043	4,304	4	−2.80	3,500	−0.008	Cando 36	No	48	N/A	N/A	N/A	N/A	56		
Benson	R	1,403	8,376	6	0.22	9,000	0.003	—	—	—	10	N/A	N/A	12	88	0	6
Ramsey	R	1,248	13,394	11	0.82	12,400	−0.003	Devils Lake 110	×	177	56	N/A	258	63	187	5	18
Nelson	R	995	6,012	6	−0.30	4,000	−0.02	McVille 19	×	29	29	N/A	43	6	98	1	9
Grand Forks	R	1,438	64,926	45	0.44	86,700	0.02	Grand Forks 88 304 Grand Forks AFB 25 Northwood 26	No × No ×	267 848 216 39	271	N/A	1,716	151	510	6	69



Population Centers near Proposed Route

TABLE 2.1-88 (Continued) COMMUNITY RESOURCES FOR COUNTIES CROSSED BY THE PROPOSED NTPC PIPELINE SYSTEM

Minnesota: County	Type	Land Area (Square Miles)[1]	1977 Population[2]	Density (Persons per square mile)[5]	Annual Growth Rate[1] 1970-1975	Projected Population 2000[2]	Projected Annual Growth Rate 1977-2000	Medical Facilities[3]: Hospitals City/Beds	Medical Facilities[3]: Intensive Care Unit	Medical Facilities[3]: Number of Personnel	Housing: Total Rental Units	Housing: Vacancy Rate (Percent)	Housing: Transient Accomodations[6]	Housing: Camper/Trailer Spaces (Near Pipeline Route)[4]	Service Establishments[7]	Police Protection: State	Police Protection: County/Local
Polk	R	2,013	36,300	18	0.48	33,700	−0.003	Crookston 100 Fosston 93	× No	236 84	2,535	1.7	179	107	387	4	57
Red Lake	R	2,062	5,300	3	1.24	5,100	−0.002	Red Lake Falls 23	×	38	275	1.5	16	10	147	1	18
Clearwater	R	1,000	9,000	9	1.54	8,300	−0.003	Bagley 50	×	68	3,265	N/A	42	5	99	1	9
Beltrami	R	2,507	30,000	12	2.68	37,900	0.01	Bemidji 135 Red Lake 30	× No	257 56	9,881	N/A	800	317	291	2	38

U.S. Department of Commerce, Bureau of the Census, County & City Data Book, 1977
SRI International, Northern Tier Environmental Assessment—Technical Report, April 1978
American Hospital Association Guide to the Health Care Field, 1978
American Automobile Association, 1978

[5] (z) indicates less than .5 persons per square mile
[6] N/A indicates information not available
[7] Service establishments include food stores, automotive dealers, general merchandise group stores, eating & drinking places, gasoline service stations, and furniture, home furnishings & equipment stores.

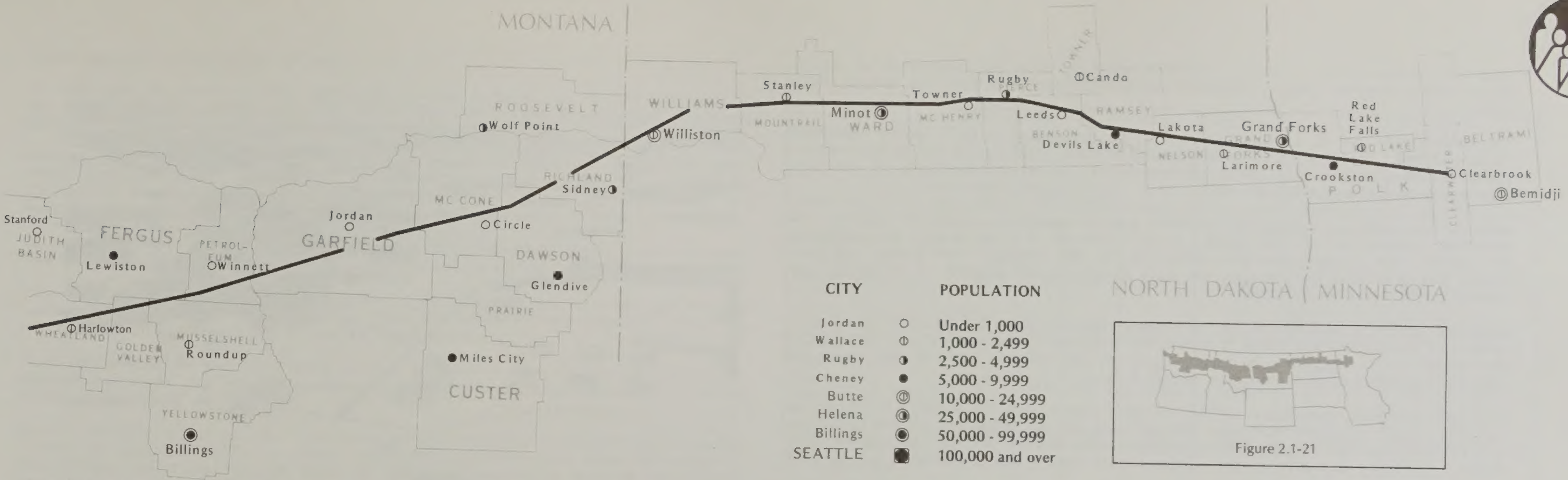


Figure 2.1-21

Rental housing is in short supply in rural counties. Most have rental vacancy rates of about 2 to 3 percent and some of the smallest counties, such as Deer Lodge, Montana, have no vacancies throughout the year (SRI International 1978). Housing is constructed on a house-by-house basis in most areas, with few provisions made for multi-family housing. Trailer parks are the most abundant form of multi-family housing. Much of the available rental housing is substandard and unfit for occupancy.

Motel accommodations are generally limited. They are usually small, with only 15 to 20 units. Some have vacancies during the winter, but are fully occupied by tourists during summer months.

Water, sewer, and solid waste systems vary from one rural county to another. However, most systems are out-dated and barely adequate for county residents. Small communities or cities usually have water and sewer systems with primary or secondary treatment plants. Some small cities have solid waste disposal services and small city dumps. Many rural residences have wells for water supplies and septic tanks for waste disposal. Almost all small town systems are old due to the limited tax base and revenues.

Schools in rural counties generally combine kindergarten through twelfth grade in one building or complex. Some grades may be combined in one classroom. Schools are rarely overcrowded. New students are welcomed and quickly assimilated. Rural counties sometimes have technical or trade schools, but usually do not offer a range of post-secondary education.

Medical services are usually provided by one or two physicians located in rural towns who serve the people living in town and on nearby farms. Many people in rural counties must travel from 50 to 100 miles for medical services. Some larger rural cities have small county hospitals.

Police and fire protection services vary from county to county. Usually, police protection in rural counties is provided by the state patrol. Some larger rural cities and counties also have small police forces of 2 to 3 officers. Many rural counties have volunteer deputy officers available for emergency situations. Cities in rural counties sometimes have a small staff of paid fire fighters, but most fire protection is provided by volunteers who usually respond to fires or emergency situations in their own vehicles, while a few go to the fire house to pick up a pumper truck. Many rural fire houses are not permanently staffed and equipment is dated.

Social services in rural counties are usually offered through informal means rather than through governmental agencies.

Some services, such as food stamps and unemployment compensation, are offered through state agencies, but usually are provided by neighbors or community groups. It is common for neighbors to bring food or donate personal services to one another in times of need.

Although the proposed pipeline system would cross the Coeur d'Alene reservation, it would be in close proximity to four other tribal groups (Skokomish, Squaxin, Nisqually and Puyallup Reservations in Washington). Table 2.1-89 provides an information summary.

Detailed data were not available. There are 14 public schools within the Flathead Reservation with a total enrollment of 4,522. Of this number, about 1,150 are Native Americans.

area and northern tier states is derived primarily from the Department of Energy, Draft Report-Petroleum Supply Alternatives for the Northern Tier and Inland States 1979.

The market area had a total of 80.4 million residents in 1977, which represents three-eights of the population of the United States. The population of the northern tiers states was 53.7 million in the same year, or about two-thirds of the total population in the market area.

Market area energy consumption in 1975 was 26 quadrillion BTU's (quads), with petroleum consumption of 9.76 quads, or 37.5 percent of total energy consumption in the market area. Total energy consumption in the northern tier states was 19.37 quads, and petroleum consumption was 6.19 quads, or 32 percent, a slightly lower proportion of total energy use.

Petroleum products consumption in the market area was about 5.7 million bpd in 1975. Crude oil production was about 1.5 million bpd. The difference between consumption and crude oil production was mainly supplied by domestic and foreign crude and petroleum products from outside the market area.

Petroleum products consumption in the northern tier states was about 3.6 million bpd in 1975. Crude oil production was 696,000 bpd, but an estimated 116,000 bpd (based on 1978 distribution patterns) was shipped to refineries outside the northern tier states. Refinery capacity in the northern tier states was 3.5 million bpd in 1978.

The curtailment of Canadian crude supplies to the northern tier states as described in the introduction, has particularly affected refinery operations in Montana, North Dakota, Minnesota, and western Wisconsin. Refiners in these states have limited access to alternative crude oil sources, and have had difficulties in obtaining adequate crude supplies. In some cases they have been required to operate at reduced levels. Supply difficulties and lowered operating levels have tended to increase product costs, but the precise effect on prices is unknown. Uncertainty about the industry's capability of meeting temporary increases in demand, such as those caused by a cold winter has been increased (Murphy 1978).

Clearbrook, Minnesota

Bureau of Land Management

SOCIAL CONDITIONS

For purpose of analysis, the counties adjacent to the proposed pipeline route have been divided into three categories, urban, semi-urban, and rural. Counties with less than 49 people per square mile were categorized as rural; those with densities between 50 and 249 were assigned to the semi-urban category; and counties with densities of more than 250 people per square mile were considered urban. Population densities are shown on table 2.1-88. Of the 61 counties adjacent to the proposed pipeline route, 3 percent are urban, 3 percent are semi-urban, and 94 percent are rural.

Infrastructure

Community infrastructure elements include housing; water supply, sewer, and solid waste disposal systems; schools; medical services; police and fire protection, and social services.

Social Well-Being and Quality of Life

As indicated in table 2.1-88, population losses occurred in 19 (38 percent) of the rural counties between 1970 and 1975. The growth rate for counties reporting population increases generally lagged behind statewide averages.

However, most of the rural counties in Washington and Minnesota registered gains above state averages. Substantial increases, above state averages, occurred in Clallam and Island Counties, Washington; Kootenai County, Idaho; Jefferson, Lake, and Mineral Counties, Montana; and in Beltrami and Clearwater Counties, Minnesota.

Current employment figures are not available, but 1970 unemployment rates in rural counties generally paralled statewide rates, except in Minnesota.

Data on per capita income shown in Table 2.1-87 indicate that in Idaho and Montana residents in rural counties had higher than statewide average incomes. This was not the case in Washington, North Dakota, or Minnesota.

Data on government services and programs in rural counties was not available. However, services are generally adequate except in counties affected by energy development related activities.

Quality of life indications in rural counties are generally rated high by residents. Lifestyles typically follow a slower, more casual pattern than urban environments. Recreational opportunities are many and varied. Aesthetic settings are highly attractive.

Resident's opinions concerning existing air and water quality are generally favorable. An emphasis on conservation, characteristic of rural residents, provides a broad base of support for environmental protection efforts.

Rural residents of Washington, Idaho, Montana, North Dakota, and western Minnesota typically have strong feelings about maintaining local and community controls as contrasted with federal regulations. Ranchers, for example, on public lands administered by the Bureau of Land Management, are skeptical about changes in grazing regulations imposed "from Washington, D.C." Concern over the designation of lands for wilderness status is high, due in part to this emphasis on the maintenance of local control.

Unemployment rates on the reservations are high. The number of jobs available is limited and it is necessary for most residents to commute to jobs in towns off the reservations. Fish enterprises (hatcheries, aquaculture, commercial harvesting) are tribal operations in each of the reservation in Washington State. These provide some local employment.

The councils on the five reservations concern themselves with the welfare of the tribal members, education of children, and future development.

The number of tribal members and Indians living on or adjacent to the reservations has risen (a variation in enumeration accounts for the apparent decline, from 1972 to 1978, in the Nisqually population reported in table 2.1-89). This growth largely results from in-migration by Native Americans who prefer to live on the reservation. Even though there are difficulties and problems with housing, schools, and employment, the reservations provide kinship and family stability, and cultural identity, as well as psychological and sociological rewards.

TABLE 2.1-89
INDIAN RESERVATION DATA

Reservation	Tribal Land Area (Acreage)	Population		Year Of U.S. Treaty	Indian Reorganization Act Constitution	Government Authority	Estimated Work Force	Unemployment Rate (Percent)
		1972	1978[1]					
Nisqually, Thurston Co., Washington	816	336	254	1857	1946	Business Council	114	26
Puyallup, Pierce Co., Washington	33	171	664	1855	1936	Tribal Council	30	37
Skokomish, Mason Co., Washington	4,987	316	489	1855	1938	Tribal Council	89	38
Squaxin Is., Mason Co., Washington	1,496	304	600	1854	1965	Tribal Council	102	47
Coeur D'Alene, Bennewah and Kootenai Co., Idaho	69,299	569	(750)	1858	1961	Tribal Council	176	53

Source: Federal and State Indian Reservations, U.S. Dept. Commerce, 1976
[1] SRI International 1978.

There are only two urban and two semi-urban counties along the proposed pipeline corridor (see table 2.1-88). Significant social impacts to these counties are not anticipated, therefore narrative description of their existing social environment has not been included.

CLALLAM COUNTY SERVICE DISTRICTS

SCHOOL & AMBULANCE

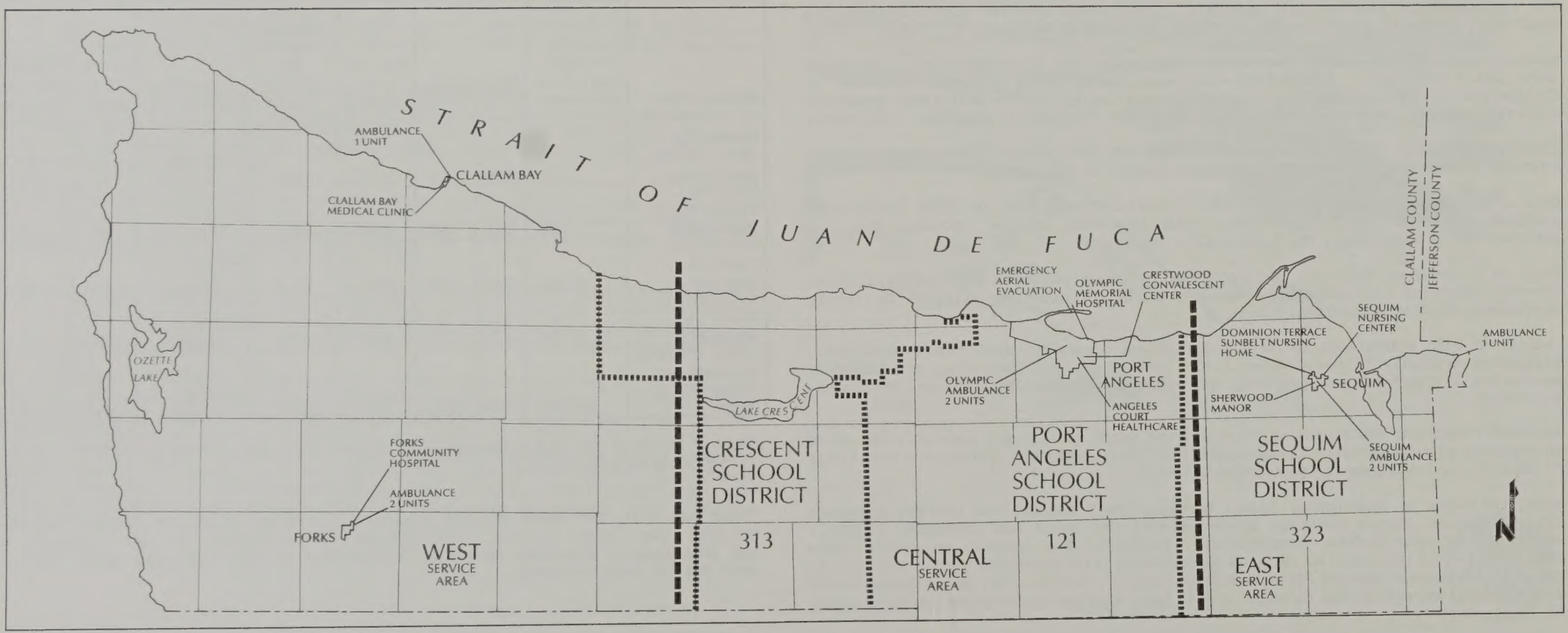


Figure 2.1-22

Source: Clallum County Governmental Conference 1977

Impacts of the Proposal

3

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MAPS

See Map Addendum.

ENVIRONMENTAL IMPACTS OF THE PROPOSAL
(Proposal of the Northern Tier Pipeline Company)

3.1 Port and Onshore Storage Facilities

OIL SPILL, FIRE, AND EXPLOSION RISK ANALYSES

The oil spill, fire, and explosion information contained in this chapter has been summarized from risk analyses made by the Oceanographic Institute of Washington (OIW) for the Crude Oil Transportation Systems Environmental Statement. Background information and specific methodology are contained in their reports: "Oil Spill Risk Analysis," October 6, 1978 (two volumes); "Fire and Explosion Hazards: Analysis and Mitigation," November 17, 1978; and "Fire and Explosion Hazards: Analysis and Mitigation," Final Report, February 13, 1979.

Although the occurrence of oil spills is probabilistic and has many causes, their chief source is human error. Therefore, any transshipment of crude oil entails a risk of spillage. This section discusses and calculates the risk of spills occurring during shipment, transfer, and storage. Those resources subject to this risk are discussed in their respective sections in this chapter.

Oil spill risk analysis attempts to assign spill probabilities based upon statistical analysis of the frequency and magnitude of similar events in the past. However, historic spill patterns do not necessarily predict their future incidence. Improved technology and stricter enforcement of updated regulations should reduce their occurrence and magnitude.

The movement of spilled oil in the marine environment is determined by local wind-generated currents, tidal phase (flood or ebb) and velocity, and, in some instances, estuarine currents. Since the location and time of a spill cannot be known in advance, oil movement predictions are hypothetical events based upon observed real conditions. Computer modeled oil spill trajectories for three locations in the Strait of Juan de Fuca are shown in chapter 3.1 Marine Resources.

Oil spill behavior involves spreading, evaporation, entrainment, dissolution in the water column, biological and chemical degradation, and sediment interaction. These phenomena are complex and not completely understood. Behavior also depends upon the hydrocarbon content of the oil and under what conditions the spill occurs. A hull rupture generally releases oil on the surface which permits rapid evaporation of the light molecular weight hydrocarbons. A submarine pipeline break on the other hand, releases oil at the sea floor where it interacts with sediment and the light hydrocarbons dissolve in the water column.

Spill risk is attendant upon each phase of oil transportation: while tankers are in transit, off-loading, or refueling; during pipeline transfers; or when in storage onshore. Since there are currently refineries and tanker traffic in greater Puget Sound, a spill risk is already present. This existing risk must be assessed before analyzing the increment added by the introduction of another transshipment system. In the discussion and tables that follow, the existing risk and the NTPC increment will be discussed separately, then combined to provide a cumulative oil spill risk.

It is important to clarify certain points which could result in a misinterpretation or misuse of the analysis. First, there is uncertainty in determining existing and incremental oil spill risk. Second, it is difficult to quantify forecasted spill sizes since volumes can be widely variable. Most spill volumes are small, but some large ones do occur. In oil spill risk analysis the use of average spill volumes can be misleading in that it tends to mask the infrequent very large spill. Therefore this analysis will not use average spill size to determine frequency, but volumes equal to or greater than (≥) 2.4 barrels. Third, the frequency of oil spills in greater Puget Sound is below national averages. Finally, the data base for computing spill probabilities in greater Puget Sound contains only those sources located in the state of Washington. Since Canadian sources are not included, estimates in this analysis would tend to be low.

The oil spill risk analysis assumes the tanker size, fleet mix, and number of port calls given in table 1.2-2. Estimated spill frequencies are expressed as "one casualty every 'X' years," but do not indicate when it might occur. The spill probabilities will be valid only as long as conditions remain significantly like those upon which the historical pattern and estimates were based.

In-transit Tanker Spills

Tanker spills can result from vessel casualties, structural and equipment failures, personnel errors, sabotage, or intentional discharge. In-transit spills are more likely to occur as the number of port calls and distance traveled to each port increases. Although these last two factors are not the only factors contributing to oil spill risk they are the only ones susceptible to a proper statistical analysis.

Statistical methods were used to identify uncertainties and establish 95 percent confidence limits for predicted spill frequency and magnitudes.

The existing spill frequency risk for tankers in transit to each of the five major harbors in greater Puget Sound, as well as the total existing in-transit risk, are presented in table 3.1-1. These figures are based on the number of tanker port calls per year at the particular harbor and the distance between the port and Cape Flattery.

Estimated spill magnitude frequencies for tankers in transit to existing harbors within greater Puget Sound are given in table 3.1-2. These statistics are based upon oil spills equal to or greater than (≥) 2.4 barrels (100 gallons). An in-transit oil spill of 2.4 or more barrels, could be expected every 1.2 years within greater Puget Sound.

Bureau of Land Management

TABLE 3.1-1 ESTIMATED SPILL FREQUENCY FOR TANKERS IN-TRANSIT TO HARBORS WITHIN GREATER PUGET SOUND (THE EXISTING RISK) (Spills ≥ 2.4 Barrels)

Harbor	Spill Frequency and Uncertainty 1/
	one spill every:
Tacoma	9.0 years (5.3-31)
Seattle	3.6 years (2.1-12)
Anacortes	7.4 years (4.4-25)
Cherry Point	3.3 years (2.0-11)
Port Angeles	69.8 years (41-239)
Total existing in-transit risk 2/	1.2 years (0.7-4.1)

Source: OIW 1978a,b

1/ The ranges shown in parentheses for each harbor and the total are estimates of the 95 percent confidence limits based on the derived historical spill rate.

2/ Based on the average number of port calls per year (from 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year), and on the distance traveled from Cape Flattery to port.

TABLE 3.1-2 ESTIMATED SPILL MAGNITUDE FREQUENCIES FOR EXISTING TANKERS IN-TRANSIT TO HARBORS WITHIN GREATER PUGET SOUND 1/

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty 2/
	one spill every:
2.4-10	2.5 years (1.5-8.6)
10.1-50	5.6 years (3.3-19)
50.1-100	24.3 years (14-83)
101-200	14.5 years (8.5-50)
201-2,000	18.3 years (11-63)
2,001-10,000	14.5 years (8.5-50)
10,000+	36.1 years (21-124)
A spill ≥ 2.4	1.2 years (0.7-4.1)

Source: OIW 1978a,b

1/ Based on the average number of port calls per year (from 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year), and on the distances traveled from Cape Flattery to port.

2/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical spill rate.

Estimated spill magnitude frequencies for the proposed NTPC tankers in transit to Port Angeles are given in table 3.1-3. One in-transit spill of 2.4 or more barrels would be expected every 3.8 years for the initial throughput (300 port calls per year) and every 2.9 years for the ultimate throughput (395 port calls per year).

TABLE 3.1-3 ESTIMATED SPILL MAGNITUDE FREQUENCIES FOR PROPOSED NTPC TANKERS IN-TRANSIT TO PORT ANGELES

Spill Magnitude	Spill Frequency and Uncertainty 1/ 709,000 barrels/day	933,000 barrels/day
	one spill every:	one spill every:
2.4-10	8.1 years (5-28)	6.1 years (4-21)
10.1-50	17.9 years (11-61)	13.6 years (8-47)
50.1-100	78.4 years (46-268)	59.4 years (35-204)
101-200	46.8 years (28-160)	35.5 years (21-122)
201-2,000	59.1 years (35-202)	44.8 years (26-154)
2,001-10,000	46.8 years (28-160)	35.5 years (21-122)
10,000+	116.4 years (68-398)	88.2 years (52-302)
A spill ≥ 2.4	3.8 years (2.3-13.1)	2.9 years (1.7-10)

Source: OIW 1978a,b

1/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical spill rate.

A comparison of total existing, incremental, and combined spill risks for in-transit tankers in greater Puget Sound is presented in table 3.1-4.

TABLE 3.1-4 ESTIMATED FREQUENCY OF IN-TRANSIT TANKER SPILLS (Spills ≥ 2.4 Barrels)

Total Existing Risk in Greater Puget Sound (513 port calls/yr).	Northern Tier Tankers to Port Angeles 709,000 bpd (300 port calls/yr)	933,000 bpd (395 port calls/yr)	Combined Northern Tier and Existing Risk 709,000 bpd (813 port calls/yr)	933,000 bpd (878 port calls/yr)
One spill every 1.2 years (0.7-4.1) 1/	One spill every 3.8 years (2.3-13)	One spill every 2.9 years (1.7-10)	One spill every 0.91 years (0.54-3.16)	One spill every 0.85 years (0.50-2.94)

Source: OIW 1978a,b

1/ Ranges shown in parentheses are estimates of the 95 percent confidence limits based on the derived historical casualty rate.

Using the estimated in-transit spill size and the frequency of its occurrence, the probable annual volume of in-transit spills can be calculated. Table 3.1-5 compares the existing annual oil spill volume from in-transit tankers in greater Puget Sound with the estimated increment from NTPC tankers which would call at Port Angeles.

TABLE 3.1-5 ESTIMATED OIL SPILLAGE PER YEAR FROM EXISTING TANKERS IN-TRANSIT IN GREATER PUGET SOUND AND FROM PROPOSED NTPC TANKERS CALLING AT PORT ANGELES

Throughput	Volume of Oil Spilled Per Year (in barrels)	
	Existing Tankers in Transit in Puget Sound	NTPC Tankers in Transit to Port Angeles
709,000 barrels/day (300 port calls/yr)	720	227
933,000 barrels/day (395 port calls/yr)	720	298

Source: OIW 1978

At-Berth Spills

The second category of oil spill risk is that for tankers at berth within a harbor. The existing at-berth spill risk for the five major tanker harbors within greater Puget Sound is given in table 3.1-6. This risk is one spill equal to or greater than 2.4 barrels every 0.39 years. The estimated spill magnitude frequencies for existing tankers at fixed berths in greater Puget Sound are presented in table 3.1-7.

TABLE 3.1-6 ESTIMATED SPILL FREQUENCY FOR TANKERS AT-BERTH IN HARBORS WITHIN GREATER PUGET SOUND (EXISTING RISK) (Spills $\geq$ 2.4 barrels)

Harbor	Spill Frequency and Uncertainty 1/
	one spill every:
Tacoma	3.6 years (2.6-6.1)
Seattle	1.2 years (0.9-2.1)
Anacortes	2.1 years (1.5-3.5)
Cherry Point	1.1 years (0.8-1.8)
Port Angeles	12.2 years (8.7-20)
Total existing at berth risk 2/	0.39 years (0.28-0.65)

Source: OIW 1978a,b

1/ The ranges shown in parentheses for each harbor and the total are estimates of the 95 percent confidence limits based on the derived historical at-berth tanker spill rate.

2/ Based on the average number of port calls per year (from 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year), and on the distance traveled from Cape Flattery to port.

TABLE 3.1-7 ESTIMATES OF FREQUENCIES OF SPILL MAGNITUDES FOR EXISTING TANKERS AT-BERTH IN HARBORS WITHIN GREATER PUGET SOUND 1/

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty 2/
	one spill every:
2.4-10	0.6 years (0.4-1.0)
10.1-50	1.6 years (1.2-2.7)
50.1-100	12.2 years (8.9-20)
101-200	17.7 years (13-30)
201-2,000	16.3 years (12-27)
2,000-10,000	78.0 years (56-130)
10,000+	195.0 years (140-325)
A spill $\geq$ 2.4	0.39 years (0.28-0.65)

Source: OIW 1978a,b

1/ Based on the average number of port calls per year (from 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year), and on the distance traveled from Cape Flattery to port.

2/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical spill rate.

Incremental fixed-berth spill frequencies were statistically based on the number of NTPC tanker port calls at Port Angeles each year. These are given in table 3.1-8. Table 3.1-9 compares the existing, incremental, and combined spill risk frequencies.

TABLE 3.1-8 ESTIMATED SPILL MAGNITUDE FREQUENCIES FOR PROPOSED NTPC TANKERS AT-BERTH IN PORT ANGELES

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty 1/ 709,000 barrels/day	933,000 barrels/day
2.4-10	1.0 years (0.7-1.7)	0.8 years (0.5-1.3)
10.1-50	2.8 years (2.0-4.7)	2.1 years (1.5-3.6)
50.1-100	20.9 years (15-35)	15.9 years (11-27)
201-200	30.5 years (22-51)	23.2 years (16-39)
2,001-10,000	134 years (9-224)	102 years (72-170)
10,000	335 years (240-560)	255 years (180-425)
A spill ≥ 2.4	0.67 years (0.48-1.12)	0.51 years (0.36-0.85)

Source OIW 1978a,b

1/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical spill rate.

TABLE 3.1-9 ESTIMATED FREQUENCY OF AT-BERTH TANKER SPILLS (Spills ≥ 2.4 Barrels)

Spill Frequency and Uncertainty				
Total Existing Risk in Greater Puget Sound (513 port calls/yr).	Northern Tier Tankers to Port Angeles 709,000 bpd (300 port calls/yr).	933,000 bpd (395 port calls/yr).	Combined Northern Tier and Existing Risk 709,000 bpd (813 port calls/yr).	933,000 bpd (878 port calls/yr).
One spill every 0.39 years (0.28-0.65)	One spill every 0.67 years (0.48-1.12)	One spill every 0.51 years (0.36-0.85)	One spill every 0.25 years (0.18-0.41)	One spill every 0.22 years (0.16-0.37)

Source: OIW 1978a,b

1/ Ranges shown in parentheses are estimates of the 95 percent confidence limits based on the derived historical casualty rate.

Table 3.1-10 compares the existing oil spill volumes from tankers at berth in greater Puget Sound with the increment which would be added by NTPC tankers berthed in Port Angeles.

TABLE 3.1-10 ESTIMATED OIL SPILLAGE PER YEAR FROM THE EXISTING TANKERS AT-BERTH IN GREATER PUGET SOUND AND FROM NTPC TANKERS BERTHED IN PORT ANGELES

Throughput	Volume of Oil Spilled Per Year (in Barrels) Existing Tankers at Berth	NTPC Tankers at Berth in Port Angeles
709,000 barrels/day (300 port calls/yr)	313	182
933,000 barrels/day (395 port calls/yr)	313	239

Source: OIW 1978c

Tank Barge Spills

Petroleum products are usually moved from port to port, or within a port, by tank barge. There are over 3,500 tank barge port calls per year in greater Puget Sound. Tank barge oil spills commonly occur during on- and off-loading or because of an accident at sea. The NTPC project proposes to use a permanently moored bunker fuel storage barge with a capacity of approximately 150,000 barrels for refueling tankers at Port Angeles. According to a recent decision by NTPC, bunker fuel for the storage barge would be supplied primarily by California refineries and shipped to the port facility in small tankers or ocean-going barges. No risk analysis has yet been made for these bunker fuel deliveries.

The existing oil spill risk (equal to or greater than 2.4 barrels) from tank barge traffic within greater Puget Sound is presented in table 3.1-11. Spill frequencies for each harbor are based upon its number of tank barge port calls per year. The estimated risk for greater Puget Sound is one tank barge spill every 0.27 years.

TABLE 3.1-11 ESTIMATED SPILL FREQUENCY FOR TANK BARGES TRAVELING WITHIN GREATER PUGET SOUND
(Spills ≥ 2.4 Barrels)

Harbor	Spill Frequency 1/
	one spill every:
Tacoma	1.93 years (1.25-4.23)
Seattle	0.62 years (0.40-1.34)
Anacortes	3.13 years (2.01-6.83)
Port Angeles	5.47 years (3.52-11.93)
Everett	8.99 years (5.79-19.62)
Total existing risk 2/	0.27 years (0.17-0.58)

Source: OIW 1978c

1/ The ranges shown in parentheses for each harbor and the total risk are estimates of the 95 percent confidence limits based on the derived historical tank barge spill rate.

2/ Based on the average number of tank barge port calls (3,521 per year) made in greater Puget Sound from 1973 to 1976.

The estimated frequencies of different spill sizes for the existing tank barge traffic in greater Puget Sound are shown in table 3.1-12.

TABLE 3.1-12 ESTIMATED SPILL MAGNITUDE FREQUENCIES FOR EXISTING TANK BARGE TRAFFIC IN GREATER PUGET SOUND 1/

Spill Magnitude (in barrels)	Spill Frequency 2/
	one spill every:
2.4-10	0.42 years (0.26-0.90)
10.1-50	1.27 years (0.80-2.72)
50.1-100	5.74 years (3.62-12.3)
101-200	7.71 years (4.86-16.6)
201-2,000	6.92 years (4.36-14.9)
2,000+	14.2 years (8.95-30.5)
A spill ≥ 2.4	0.27 years (0.17-0.58)

Source: OIW 1978c

1/ Based on the average number of tank barge port calls (3,521 per year) made in greater Puget Sound from 1973 to 1976.

2/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical tank barge spill rate. These were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills from tank barges.

Oil Spills - Other Vessels

Most vessels in greater Puget Sound carry petroleum for fuel and represent a further oil spill risk. For example, spills frequently occur during refueling when bunker tanks are overfilled. The estimated average amount of oil spilled each year by various vessel types is presented in table 3.1-13. Tugs and towboats spill the largest volume, with dry cargo ships a distant second.

TABLE 3.1-13 CONTRIBUTION OF VESSELS OTHER THAN TANK SHIPS AND TANK BARGES TO THE EXISTING LEVEL OF OIL INPUTS TO GREATER PUGET SOUND
1973-1976

Vessel Type	Average Number of Spills per Year	Percent of Total 1/	Average Volume Spilled Per Year (barrels)	Percent of Total 1/
Dry cargo ship	17	16	33	17
Dry cargo barge	4	4	4	2
Tug or towboat	17	16	107	54
Fishing vessel	26	24	15	8
Passenger vessel	4	4	3	2
Recreational vessel	13	12	6	3
Combat vessel	7	6	10	5
Other public vessels	8	7	2	1
Unknown vessels	13	12	17	9
Total	109	101	197	101

Source: U.S. Coast Guard Pollution Incident Reporting System data; OIW 1978c

1/ Total may not add up to 100 percent due to rounding error.

Terrestrial Sources of Oil Pollution to the Marine Environment

Knowledge of existing oil inputs into the marine environment from land sources, excluding onshore storage facilities and pipelines, is necessary for calculating the magnitude of petroleum pollution prior to the introduction of additional crude oil transshipment systems. Pollution from terrestrial sources would include not only crude oil but also petroleum products from such sources as coastal refineries, municipal wastewater and non-refinery industries, urban runoff, and land accidents resulting in oil spillage.

The estimated oil spill volumes into greater Puget Sound from the various land sources is given in table 3.1-14. The largest sources were effluents from municipalities and non-refinery industries.

TABLE 3.1-14 ESTIMATED ANNUAL CONTRIBUTION OF OIL INTO THE MARINE ENVIRONMENT FROM TERRESTRIAL SPILLS IN THE GREATER PUGET SOUND AREA

Spill Source	Estimated Oil Inputs (barrels per year)
Coastal refineries	263
Municipal wastewater and non-refinery industrial waste	34,900
Urban runoff	9,337
Marine and land transportation facilities	540
Total from terrestrial spills	45,040

Source: OIW 1978b

Onshore Storage Facility Spills

Potential causes of oil spills at onshore storage facilities are equipment failure, personnel error, sabotage, natural disasters, and fire and explosions. While equipment failure and personnel error result in frequent but low volume spills, disasters, fire, and explosion could result in high spill volumes that would cause significant impacts on many resources.

The estimated spill frequencies for existing storage facilities in the greater Puget Sound area are shown in table 3.1-15. Spill frequency at the current storage volume in greater Puget Sound is one every 0.43 years (2.3 spills per year), while at maximum existing capacity the risk is one every 0.19 years (5.3 spills per year). As it is unlikely that all storage tanks in greater Puget Sound would be full at the same time, this latter figure must represent a worst case spill frequency risk.

TABLE 3.1-15 ESTIMATED SPILL FREQUENCIES FROM ONSHORE STORAGE FACILITIES IN THE GREATER PUGET SOUND AREA
(Existing Risk)
(Spills $\geq$ 2.4 Barrels)

Storage Volume	Spill Frequency and Uncertainty 1/
	one spill every:
Current storage volume (13,491,666 barrels)	0.43 years (0.35-0.55)
Maximum storage volume (30,453,352 barrels)	0.19 years (0.16-0.24)

Source: OIW 1978

1/ The ranges shown in parentheses are estimates of the 97 percent confidence limits based on the derived historical onshore storage spill rate.

These estimated worst case spill magnitude frequencies for storage facilities within greater Puget Sound are given in table 3.1-16.

TABLE 3.1-16 ESTIMATED ONSHORE STORAGE SPILL MAGNITUDE FREQUENCIES FOR EXISTING MAXIMUM STORAGE VOLUME IN THE GREATER PUGET SOUND AREA
(Spills $\geq$ 2.4 Barrels)

Spill Magnitudes (in barrels)	Spill Frequency and Uncertainties 1/
	one spill every:
2.4-10	0.53 years (0.43-0.68)
10.1-100	0.38 years (0.31-0.50)
101-1,000	1.40 years (1.14-1.80)
1,001-10,000	17.30 years (14.1-22.2)
A spill $\geq$ 2.4	0.19 years

Source: OIW 1978

1/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical onshore storage spill rate. These were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills from storage facilities.

Port Angeles and Harbor

Northwest Air Photos, Port Orchard, Washington 1974

The estimated spill magnitude frequencies for the NTPC onshore storage facility for the initial (5,995,000 barrels) and ultimate (9,810,000 barrels) storage capacities are presented in table 3.1-17.

TABLE 3.1-17 ESTIMATED NTPC ONSHORE STORAGE SPILL MAGNITUDE FREQUENCIES (Spills ≥ 2.4 Barrels)

Spill Magnitudes (in barrels)	Spill Frequency and Uncertainty 1/ 5,995,000 Barrels (initial throughput)	9,810,000 Barrels (ultimate throughput)
	one spill every:	one spill every:
2.4-10	2.7 years (2.2-3.5)	1.6 years (1.4-2.1)
10.1-100	2.0 years (1.6-2.5)	1.2 years (1.0-1.5)
101-1,000	7.1 years (5.9-9.1)	4.4 years (3.6-5.6)
1,001-10,000	91 years (72-111)	53 years (44-67)
A spill ≥ 2.4	0.96 years (0.78-1.25)	0.59 years (0.48-0.76)

Source: OIW 1978

1/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical onshore storage spill rate. These were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills from storage facilities.

The expected yearly oil spill volumes from the proposed project and existing onshore storage facilities in the greater Puget Sound area are given in table 3.1-18.

TABLE 3.1-18 ESTIMATED ANNUAL OIL SPILL RISK FOR NTPC AND EXISTING STORAGE FACILITIES IN THE GREATER PUGET SOUND AREA

Storage Volumes (barrels)	Spillage Risk (barrels per year)
Greater Puget Sound:	
Maximum storage volume 30,453,352	365
Proposed NTPC volumes:	
Initial 5,995,000	72
Ultimate 9,810,000	117

Source: OIW 1978c

Comparison of Existing Spill Risk and NTPC Increment

To adequately assess the incremental oil spill risk of the proposed project, it is necessary to identify the existing oil pollution baseline level within greater Puget Sound. Both point and non-point sources contribute directly and indirectly to the oil volume that enters greater Puget Sound. Oil pollution of the marine environment can be caused by tankers, tank barges and other vessels; marine facilities; coastal refineries, pipelines, and onshore storage facilities; land accidents; as well as by municipal and industrial wastewater and urban runoff. The proposed NTPC project would further increase oil spillage in greater Puget Sound, as each element of its transportation system constitutes an additional increment of spill risk over the present situation.

Table 3.1-19 presents estimates of existing annual oil spill volume in greater Puget Sound and the incremental volume associated with the proposed project.

TABLE 3.1-19 COMPARISON OF EXISTING AND NTPC INCREMENT OF OIL SPILL VOLUMES

	Existing Volume of Oil Spilled Per Year in Greater Puget Sound (barrels)	Volume of Oil Spilled Per Year Associated with the NTPC System (barrels)	
		709,000 bbl/day throughput	933,000 bbl/day throughput
Other vessels	197	—	—
Tankers at-berth	313	182	239
Onshore storage facilities	365	72	117
Pipelines	523	111 1/	111 1/
Tank barges	596	0 2/	0 2/
Tankers in-transit	720	227	298
Other land sources	45,040	—	—
Total barrels	47,754	592 2/	765 2/

Source: OIW 1978c

1/ Spill risk for 80 miles of onshore pipeline and 20 miles of offshore pipeline to North Bend, Washington (see section 3.2 Pipeline System: Oil Spill, Fire, and Explosion Risk Analysis).

2/ Use of tank barges is no longer part of the NTPC proposal. Data are not available for potential spill volumes from tankers or barges required for delivery of bunker fuel and diesel to the proposed NTPC port facility. The total indicated would be higher if these data were included.

Fire and Explosion Risk Analysis

In-Transit Tanker

This analysis addresses only the risk associated with tanker casualties caused by fires or explosions, not the risk associated with all tanker casualties in transit. U.S. Coast Guard casualty data for the years 1969-1975 were used in the analysis. The exposure variable utilized was distance traveled per port call, assuming the greater the distance the longer the tanker would be exposed to hazards and events which cause fire and explosion casualties. It should be emphasized, however, that port calls and distance traveled still do not account for all factors contributing to fire and explosion risk. Analysis of the historical occurrence of tanker fire and explosion casualties in the eight major tanker ports-of-call in the U.S. (including greater Puget Sound) were applied to harbors within greater Puget Sound to estimate the existing risk of tanker fires and explosions. The estimated rate was then applied to the NTPC proposal to calculate the potential incremental risk.

Fire

The existing in-transit fire risks to five major tanker harbors within greater Puget Sound are presented in table 3.1-20. Total existing in-transit risk is approximately one tanker fire every 35 years.

TABLE 3.1-20 ESTIMATED FIRE FREQUENCY FOR TANKERS TRAVELING TO HARBORS WITHIN GREATER PUGET SOUND (EXISTING FIRE RISK--COASTAL AREAS) 1/

Harbor	Fire Frequency
	one fire every:
Tacoma	270 years
Seattle	110 years
Anacortes	220 years
Cherry Point	99 years
Port Angeles	2,100 years
Total existing tanker risk 2/	35 years

Source: OIW 1979

1/ Coastal areas extend from harbor entrances to 50 miles off-shore.

2/ Based on the average number of tanker port calls per year (from 1973 to 1976) to the five largest tanker harbor calls within greater Puget Sound (513 port calls/year), and on the distances traveled to each port.

Estimated in-transit fire risks in coastal areas for NTPC tankers during the initial and ultimate throughput phases would be one fire every 110 and 87 years respectively.

The estimated combined risk (existing plus NTPC increment) for in-transit tankers in coastal areas would be one fire every 27 years for the initial throughput and one every 15 years for the higher volumes of the ultimate phase.

Explosion

The estimated existing explosion frequency for tankers traveling to harbors within greater Puget Sound is presented in table 3.1-21. The existing risk is one explosion every 31 years.

TABLE 3.1-21 ESTIMATED EXPLOSION FREQUENCY FOR TANKERS TRAVELING TO HARBORS WITHIN GREATER PUGET SOUND (EXISTING EXPLOSION RISK - COASTAL AREAS) 1/

Harbor	Explosion Frequency
	one explosion every:
Tacoma	240 years
Seattle	95 years
Anacortes	200 years
Cherry Point	88 years
Port Angeles	1,800 years
Total existing tanker risk 2/	31 years

Source: OIW 1979

1/ Coastal areas extend from harbor entrances to 50 miles off-shore.

2/ Based on the average number of port calls per year (from 1973 to 1976 to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year), and the distances traveled to each port.

The estimated incremental risk in coastal areas for NTPC tankers traveling to Port Angeles would be one explosion every 100 years during the initial phase, and one every 77 years for ultimate throughput.

The combined risk of tanker explosion in coastal areas (existing traffic plus the NTPC increment) would be one every 24 years at the initial throughput volumes and one every 22 years during the ultimate phase.

Harbor Areas

The exposure variable used to calculate harbor fire and explosion risks was total average number of port calls per year. Harbor areas were defined to include the harbor entrance, harbor, river or canal, and berth.

Fire

The expected frequencies of fires for tankers utilizing harbors within greater Puget Sound are presented in table 3.1-22. Existing harbor fire risk in this region is estimated to be one every 15 years.

TABLE 3.1-22 ESTIMATED FIRE FREQUENCY FOR TANKERS UTILIZING HARBORS WITHIN GREATER PUGET SOUND (EXISTING FIRE RISK - HARBOR AREAS) 1/

Harbor	Fire Frequency
	one fire every:
Tacoma	140 years
Seattle	49 years
Anacortes	83 years
Cherry Point	43 years
Port Angeles	480 years
Total existing tanker risk	15 years

Source: OIW 1979

1/ Based on the average number of port calls per year (from 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year).

The frequencies of fires anticipated from NTPC tankers in Port Angeles harbor would be one every 26 years for the 709,000 barrels per day volume, and one every 20 years for the throughput of 933,000 barrels per day. These represent the incremental risks.

The estimated combined risk of tanker fires occurring in the major harbors of greater Puget Sound would be one every 9.7 years at the initial throughput, and one every 8.7 years for the ultimate amount.

Explosion

Explosion risk frequencies for existing tankers utilizing harbors within greater Puget Sound are given in table 3.1-23. The estimated total risk for harbor explosions is one every 37 years.

TABLE 3.1-23 ESTIMATED EXPLOSION FREQUENCY FOR TANKERS UTILIZING HARBORS WITHIN GREATER PUGET SOUND (EXISTING EXPLOSION RISK - HARBOR AREAS) 1/

Harbor	Explosion Frequency
	one explosion every:
Tacoma	350 years
Seattle	120 years
Anacortes	200 years
Cherry Point	100 years
Port Angeles	1,200 years
Total existing tanker risk 1/	37 years

Source: OIW 1979

1/ Based on the average number of port calls per year (from 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year).

Estimated frequencies of explosions from NTPC tankers in Port Angeles for the initial and ultimate throughputs would be one explosion every 63 years and 49 years respectively.

Finally, the combined estimated frequencies of tanker exlosions in the harbors of greater Puget Sound would be one every 24 years at the initial throughput, and one every 21 years for the ultimate volume.

Onstore Storage Facility

Fire and Explosion

Fire risk frequencies for onshore storage facilities were estimated by means of a standard statistical analysis of storage fires listed in the American Petroleum Institute's (API) "Reported Fire Loss in the Petroleum Industry" between 1972 and 1976. The utility of these data is limited by several factors: 1) fire information was voluntarily supplied to API; 2) only fires causing more than $1,000 damage were included; and 3) no distinction was made between fires in large or small storage areas. In addition, API used a frequency of fires per 100 properties in analyzing its data. Break downs employing other exposure variables, such as fires per tank per year or fires per barrel throughput, were not made. As fire frequency was related only to the number of storage facilities, rate differentiations between initial and ultimate throughputs could not be made. Finally, since explosions were not treated separately in the API data, the following analysis does not provide discrete information on explosion risk.

Potential causes of fires and explosions are equipment failure, personnel error, sabotage, natural disasters, and fires or explosions outside the storage facility.

The estimated incremental risk for a fire causing damage equal to or greater than $1,000 is one every 64 years. The estimates of frequencies of fire magnitudes from the proposed project are presented in table 3.1-24.

TABLE 3.1-24 ESTIMATED FREQUENCY OF FIRE DAMAGE FOR PROPOSED NTPC ONSHORE STORAGE FACILITY 1/

Fire Damage Magnitude	Fire Frequency and Uncertainty 2/
	one fire every:
$ 1,000 to $10,000	145 years (95-300)
$ 10,000 to $100,000	290 years (190-605)
$100,000 to $500,000	225 years (150-475)
over $500,000	1,060 years (695-2,200)
A fire ≥ $1,000 damage	64 years (42-133)

Source: OIW 1979

1/ Estimates are the same for both 709,000 and 933,000 barrels per day throughput.

2/ The ranges shown in parentheses for each fire damage magnitude category are estimates of the 95 percent confidence limit, and were calculated by assuming that the variance of each fire magnitude category was equal to the variance of the data for all fires.

Summary of Fire and Explosion Risks

Table 3.1-25 was synthesized from the preceeding discussions to bring together the various fire, explosion, and human fatality risks associated with the NTPC proposal.

TABLE 3.1-25 TOTAL EXISTING RISK WITHIN GREATER PUGET SOUND, INCREMENTAL RISK FROM NTPC TANKERS, AND COMBINED RISK OF FIRE AND EXPLOSION

Incident	Total Existing Risk Within Greater Puget Sound	Incremental Risk for NTPC Proposal		Combined Risk	
		709,000 barrels/day	933,000 barrels/day	709,000 barrels/day	933,000 barrels/day
In-Transit Tanker Explosion	One every:	One every:	One every:	One every:	One every:
	≈31 years	≈100 years	≈77 years	≈24 years	≈22 years
Harbor Tanker Explosion	≈37 years	≈63 years	≈49 years	≈24 years	≈21 years
In-Transit Tanker Fire	≈35 years	≈110 years	≈87 years	≈27 years	≈25 years
Harbor Tanker Fire	≈15 years	≈26 years	≈20 years	≈9.7 years	≈8.7 years
Onshore Storage Facility Fire and Explosion	A fire $1,000 damage once every 64 years (42 to 133) 1/				
Onshore Storage Facility Fire and Explosion Fatality	One fatality every: 900 years (820 to 1,000)				

Source: OIW 1979

1/The range in parentheses for onshore storage facility fire damage is an estimate of the 95 percent confidence limits.

≈ approximately

Consequences of Fires and Explosions

An explosion results from a sudden release of energy. Explosive yield is expressed in terms of TNT equivalence. An explosion dissipates rapidly causing 1) blast waves from overpressure, 2) thermal radiation resulting in primary and secondary fires, and 3) projection of flying objects.

Certain important points must be made regarding the analysis of fires and explosions. It is difficult to obtain consistent data about low level explosion impacts because 1) most recent research has been conducted by the Department of Defense and is not available, and 2) most studies have concentrated on high yield explosions. However, certain information may be extrapolated from tables for high explosive compounds. These values represent exaggerated (worst-case) parameters for a contained vapor explosion.

Blast Waves

Blast waves from different explosives can be equated using a conversion to an equivalent weight or energy of a standard TNT explosive.

The intensity of an explosive yield depends upon the rapidity of decomposition. Substances which detonate are those in which decomposition occurs at a rate of thousands of meters per second. Other substances deflagrate or burn rapidly, in which case decomposition rates do not exceed a few meters per second. Deflagration, by itself, does not produce an explosion unless it is confined, as in a container. If the pressure is great enough to burst the container the effects will be similar to a true explosion. For a surface explosion the damage range of blast effects is three fourths that of an air explosion of the same yield.

Thermal Radiation

Thermal radiation contributes to fire or explosion damage by igniting combustible materials. It also causes skin burns, eye injuries, and possible death to exposed individuals.

Human injuries and ignition of combustibles depend upon the amount of thermal energy received per unit area within a short time interval. The amount of radiation received depends upon the size of the fire ball and its distance from exposed materials or persons.

Thermal radiation received at a given point from an explosion is less if the air is not clear.

Fire spread depends upon the distances between combustible objects. Figure 3.1-1 expresses the approximate percentage of fire spreading as related to distance between combustible materials.

Another consequence of thermal radiation from an explosion is skin burns. First-degree burns over a major portion of the body can be fatal. Extensive second-degree burns will normally incapacitate the victim. Figure 3.1-2 gives extrapolated distances for first- and second-degree burns for different TNT equivalents.

Width of Gap in Probability of Fire Spread

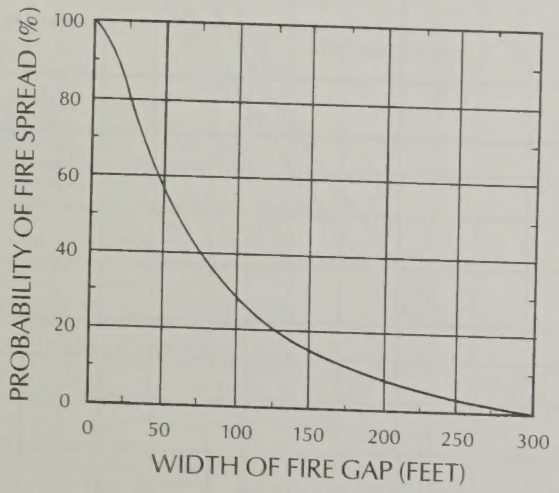


Figure 3.1-1

Oceanographic Institute of Washington, 1979.

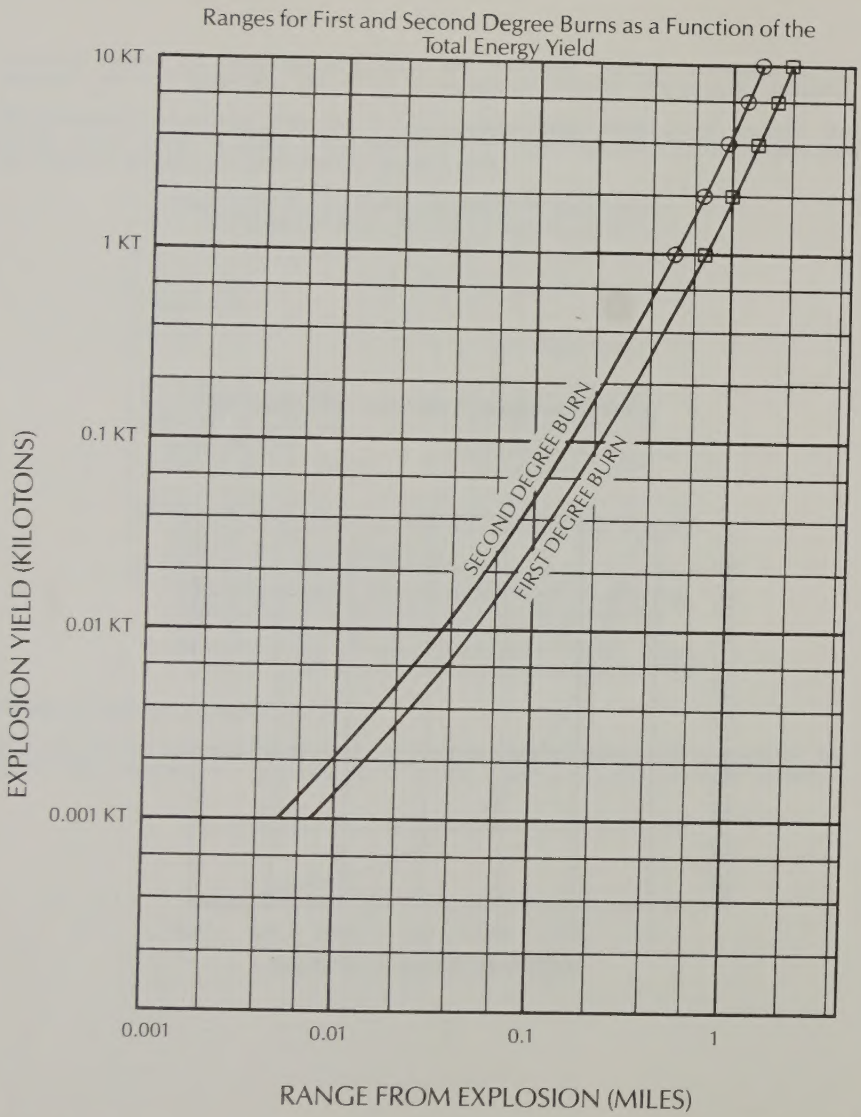

Ranges for First and Second Degree Burns as a Function of the Total Energy Yield

Figure 3.1-2

Source: Oceanographic Institute of Washington, 1979.

Projection of Objects

An explosion transfers energy to nearby objects which will be propelled from the site. The distance an object is propelled is determined by 1) the energy imparted to the object, 2) the mass of the object, and 3) the direction of motion given to the object. Damage from an object is determined by the mass and velocity upon impact. A loose object will be projected at a greater velocity than an object which must be torn loose before projection. There are many unknowns which do not permit calculation of the distance an object may be propelled. These unknowns are 1) the amount of energy absorbed in tearing the object loose, 2) the inertia of the object, 3) the shape of the object, 4) the areodynamic drag of the object, and finally, 5) the effects of wind.

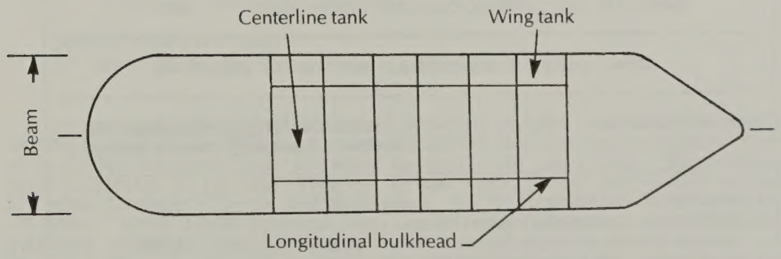
Site Specific Events

Tanker Explosion

Three hypothetical explosions involving 300,000 dead-weight-ton crude oil tankers are considered. These events are 1) a most probable accident, 2) a worst probable accident, and 3) the worst possible accident. The results of these hypothetical cases have been calculated from data on 95 tankship explosions occurring worldwide between 1969 and 1973. A schematic plan of a tanker with 18 tanks is shown in figure 3.1-3, which will aid in the following discussion of tanker explosive events.

Most Probable Accident. A most probable accident would involve the explosion of a single centerline tank. This could occur if the inerting system were not functioning properly and an optimum vapor/air mixture was present in the 1,202,733 cubic foot tank. Detonation of the hydrocarbon vapor/air mixture would be equivalent to 63 tons of TNT. Damages to humans and structures from such an explosion are given in table 3.1-26. The fire ball would have a 30-foot radius and the probability of fire spread at 200 feet would be 12 percent. Second-degree burns could occur at 1,100 feet while first-degree burns would be expected at 1,600 feet.

Schematic Tanker Plan



Schematic Plan, Tanker with 18 tanks. (6 centerline tanks, 12 wing tanks). The longitudinal bulkheads separating wing tanks from centerline tanks are located inboard 1/5 of the beam.

Capacity of a wing tank $= \frac{DWT}{30}$

Capacity of a centerline tank $= \frac{DWT}{10}$

Figure 3.1-3

Source: Oceanographic Institute of Washington, 1979.

TABLE 3.1-26 63 EQUIVALENT TONS OF TNT EXPLOSION
(Most Probable Tanker Explosion)

DISTANCES FOR VARIOUS BLAST INJURIES

Injury	Distances (ft.) 1/
Mostly safe (whole body)	734
Skull fracture threshold	636
Fracture feet and legs	587
Skull fracture near 50% probability	538
Lethality threshold (whole body)	509
Skull fracture near 100 % probability	480
Lethality near 50% probability (whole body)	440
Lethality near 100% probability (whole body)	392

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
1. Wood-frame building	1,074	776
2. Multistory, wall-bearing buildings, brick apartment house type	806	567
3. Multistory wall-bearing buildings, monumental type	537	418
4. Multistory, blast-resistant design, reinforced-concrete buildings	239	179
5. Multistory, reinforced-concrete buildings, with concrete walls and small window area	478	299
6. Highway truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)		
7. Multistory, reinforced-concrete, frame office type buildings, earthquake resistant	269	194
8. Light steel-frame industrial buildings	448	269
9. Heavy steel-frame industrial buildings (25- to 50-ton crane)	388	239
10. Heavy steel-frame industrial buildings (60- to 100-ton crane)	329	209
11. Railroad truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	329	209
12. Multistory, reinforced-concrete frame office type buildings	329	209

TABLE 3.1-26 (Continued)

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES		
Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
13. Highway and railroad truss bridges of 250 to 400 foot span (blast normal to longitudinal bridge axis)	329	209
14. Multistory, steel-frame office type buildings, earthquake resistant	239	164

Source: OIW 1979 (Rev)
1/ After correction for surface/air burst.

Buildings in Port Angeles

BLM

Worst Probable Accident. A worst probable accident would involve the simultaneous explosion of nine cargo tanks. In this case it is assumed that one centerline tank would explode causing the concurrent detonation of eight adjacent tanks. The total capacity of the nine tanks would be 6,013,665 cubic feet. The TNT equivalent for such an explosion is 313 tons. Resulting damages to human life and structures at different distances are shown in table 3.1-27. The fire ball radius would be 56 feet and the probability of fire spread at 200 feet is 14 percent. Second degree burns could occur at 1,500 feet and first-degree burns at 2,100 feet.

TABLE 3.1-27 313 EQUIVALENT TONS OF TNT EXPLOSION
(Worst Probable Tanker Accident)

DISTANCES FOR VARIOUS BLAST INJURIES	
Injury	Distances (ft.) 1/
Mostly safe (whole body)	1,253
Skull fracture threshold	1,086
Fracture feet and legs	1,002
Skull fracture near 50% probability	919
Lethality threshold (whole body)	869
Skull fracture near 100% probability	818
Lethality near 50% probability (whole body)	752
Lethality near 100% probability (whole body)	668

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES		
Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
1. Wood-frame building	1,875	1,350
2. Multistory, wall-bearing buildings, brick apartment house type	1,350	1,050
3. Multistory, wall-bearing buildings, monumental type	1,050	675
4. Multistory, blast-resistant design, reinforced-concrete buildings	518	300
5. Multistory, reinforced-concrete buildings, with concrete walls and small window area	750	518
6. Highway truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	450	315
7. Multistory, reinforced-concrete, frame office type buildings, earthquake resistant	450	315

TABLE 3.1-27 (Continued)

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
8. Light steel-frame industrial buildings	668	510
9. Heavy steel-frame industrial buildings (25- to 50-ton crane)	600	383
10. Heavy steel-frame industrial buildings (60- to 100-ton crane)	525	353
11. Railroad truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	525	353
12. Multistory, reinforced-concrete frame office type buildings	525	353
13. Highway and railroad truss bridges of 250- to 400-foot span (blast normal to longitudinal bridge axis)	525	353
14. Multistory, steel-frame office type buildings	450	293
15. Multistory, steel-frame office type buildings, earthquake resistant	390	255

Source: OIW 1979 (Rev)
1/ After correction for surface/air burst.

Worst Possible Accident. A worst possible accident would be the simultaneous explosion of all cargo tanks. No such detonation has ever been recorded. The volume of the cargo for this situation would be 12,027,330 cubic feet. The resulting fire would be limited to residual crude oil in the tanks, bunker fuel aboard the ship, and any other flammables in the ship's stores. The TNT equivalent for this explosion is 625 tons. Table 3.1-28 presents injuries to human life and damage to structures at different distances from explosion. The fire ball radius from such an explosion would be about 75 feet, the probabliity of fire spreading at a distance of 200 feet would be 18 percent. Second-degree burns would occur at 2,100 feet and first-degree burns at 3,200 feet.

TABLE 3.1-28 625 EQUIVALENT TONS OF TNT EXPLOSION
(Worst Possible Tanker Accident)

DISTANCES FOR VARIOUS BLAST INJURIES

Injury	Distances (ft.) 1/
Mostly safe (whole body)	1,577
Skull fracture threshold	1,367
Fracture feet and legs	1,261
Skull fracture near 50% probability	1,157
Lethality threshold (whole body)	1,093
Skull fracture near 100% probability	1,030
Lethality near 50% probability (whole body)	946
Lethality near 100% probability (whole body)	841

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
1. Wood-frame building	2,250	1,650
2. Multistory, wall-bearing buildings, brick apartment house type	1,575	1,350
3. Multistory, wall-bearing buildings, monumental type	1,275	900
4. Multistory, blast-resistant design, reinforced-concrete buildings	525	375
5. Multistory, reinforced-concrete buildings, with concrete walls and small window area	975	638
6. Highway truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis	563	413
7. Multistory, reinforced-concrete, frame office type buildings, earthquake resistant	563	413
8. Light steel-frame industrial buildings	825	563
9. Heavy steel-frame industrial buildings (25- to 50-ton crane)	750	525
10. Heavy steel-frame industrial buildings (60- to 100-ton crane)	675	450
11. Railroad truss bridges of 150 to 250 foot span (blast normal to longitudinal bridge axis)	675	450
12. Multistory, reinforced-concrete frame office type buildings	675	450

TABLE 3.1-28 (Continued)

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
13. Highway and railroad truss bridges of 250- to 400-foot span (blast normal to longitudinal bridge axis)	675	450
14. Multistory, steel-frame office type buildings	563	413
15. Multistory, steel-frame office type buildings, earthquake resistant	525	338

Source: OIW 1979 (Rev)

1/ After correction for surface/air burst.

A further refinement of damage estimates from a worst-case tanker explosion is provided below and is illustrated on the following page. These consequences can be compared with those described in chapter 8. They significantly extend the distance in which structural damages to buildings would occur while generally affirming the estimated distances within which human injuries or fatalities would be expected.

Onshore Storage Facility Explosion

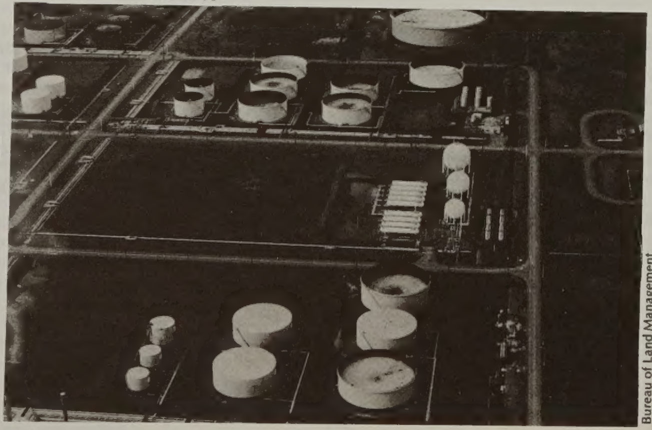
Storage tanks with floating roofs have a negligible explosion hazard. However, the posibility of explosion exists due to mechanical failure or human error. A more probable and worst probable accident at the onshore storage facility are considered.

Most Probable Accident. A storage tank explosion could result from vapors in an empty tank which is in preparation for cleaning. The volume of a proposed NTPC tank when the roof is 6 feet high is 370,000 cubic feet. The TNT equivalent for such an explosion would be about 19 tons. If vapors were ignited the tank roof would lift and a semi-contained explosion would occur. The fire ball radius would be about 18.5 feet and the probability of fire spreading at 150 feet (the approximate distance between tanks) would be approximately 18 percent. Blast injuries to humans and potential structural damage are presented in table 3.1-29. Second-degree burns would occur at 300 feet and first-degree burns at 400 feet.

POSSIBLE TANKER EXPLOSION CONSEQUENCES
(327,000 dwt)

Type of Damage	Radial Distance (feet)
Human Casualties:	
Mostly safe	1,500
Lethality threshold	1,100
Lethality near 50% probability	1,000
Lethality near 100% probability	940
Structural Damage:	
Wood Frame	
Scattered	6,300
Moderate	3,200
Severe	2,500
Brick, Multistory	
Scattered	6,300
Moderate	2,600
Severe	1,900
Light Steel Frame Industrial	
Scattered	6,300
Moderate	1,200
Severe	850

Source: OIW 1979



Bureau of Land Management

Onshore storage facilities at Cherry Point, Washington showing floating roof feature.

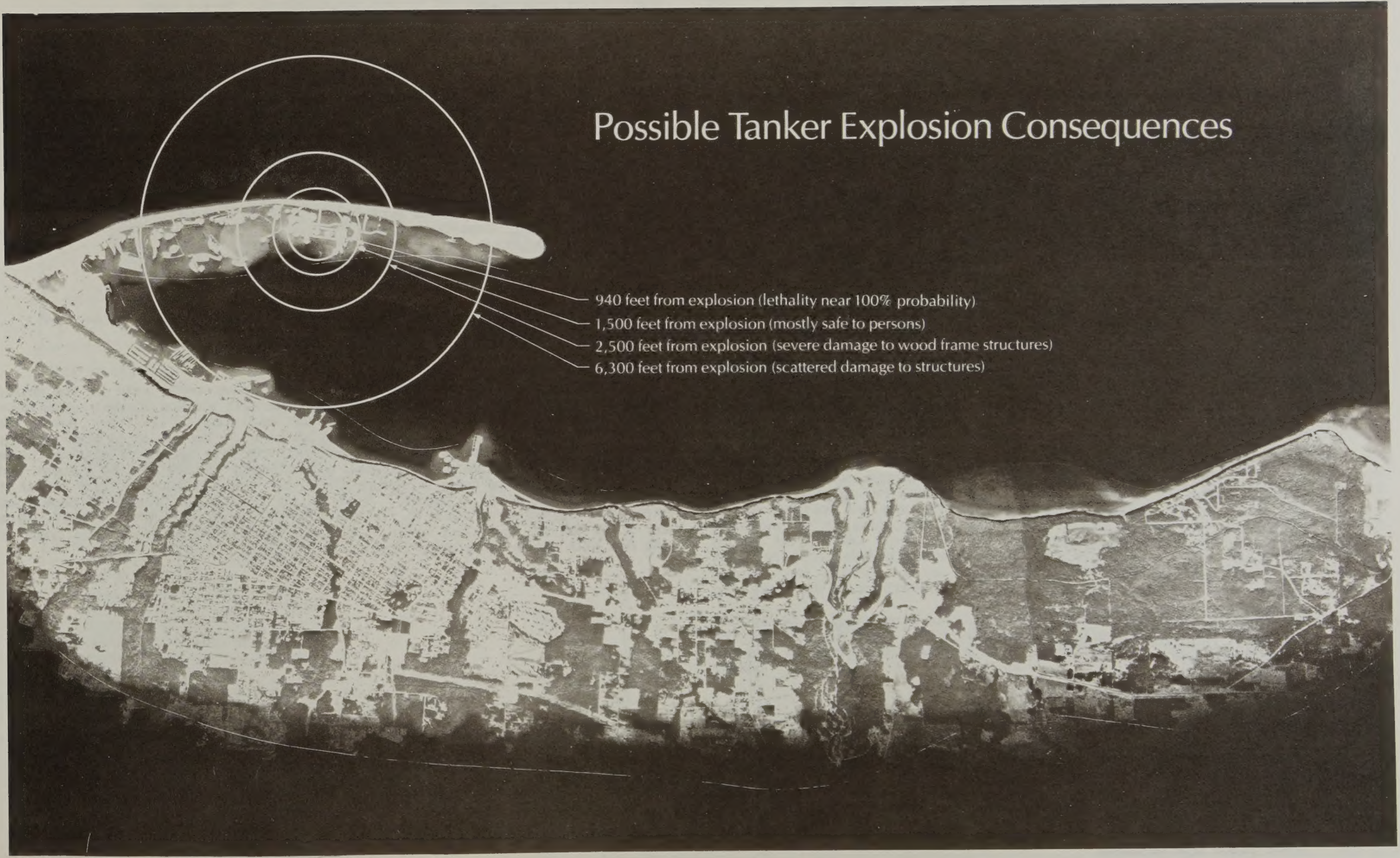

Possible Tanker Explosion Consequences
940 feet from explosion (lethality near 100% probability)
1,500 feet from explosion (mostly safe to persons)
2,500 feet from explosion (severe damage to wood frame structures)
6,300 feet from explosion (scattered damage to structures)

TABLE 3.1-29 19 EQUIVALENT TONS OF TNT EXPLOSION
(Most Probable Onshore Storage Facility Accident)

DISTANCES FOR VARIOUS BLAST INJURIES

Injury	Distances (ft.) 1/
Mostly safe (whole body)	492
Skull fracture threshold	427
Fracture feet and legs	394
Skull fracture near 50% probability	361
Lethality threshold (whole body)	341
Skull fracture near 100% probability	322
Lethality near 50% probability (whole body)	295
Lethality near 100% probability (whole body)	263

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES

TABLE 3.1-29 (Continued)

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
1. Wood-frame building	720	521
2. Multistory, wall-bearing buildings, brick apartment house type	540	380
3. Multistory, wall-bearing buildings, monumental type	360	280
4. Multistory, blast-resistant design, reinforced-concrete buildings	160	120
5. Multistory, reinforced-concrete buildings, with concrete walls and small window area	320	200
6. Highway truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	180	130
7. Multistory, reinforced-concrete, frame office type buildings, earthquake resistant	180	130
8. Light steel-frame industrial buildings	300	180
9. Heavy steel-frame industrial buildings	260	160
10. Heavy steel-frame industrial buildings (60- to 100-ton crane)	220	140
11. Railroad truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	220	140
12. Multistory, reinforced-concrete frame office type buildings		
13. Highway and railroad truss bridges of 250 to 400 foot span (blast normal to longitudinal axis)	220	140
14. Multistory, steel-frame office type buildings	180	130
15. Multistory, steel-frame office type buildings, earthquake resistant	160	110

Source: OIW 1979 (Rev)

1/ After correction for surface/air burst.

Worst Probable Accident. A worst probable accident could occur if the entire volume of a tank containing an optimum hydrocarbon-air mixture ignited. The vapor volume would be 3,052,000 cubic feet with a TNT equivalent of 159 tons. Again, the tank roof would lift and a semicontained explosion would occur. If adjacent storage tanks were not detonated by projected missiles, the fire spread to adjacent tanks would depend upon atmospheric conditions, effectiveness of tank cooling systems, and ability of firefighting crews to contain the fire. The probability of fire spread at 150 feet would be about 25 percent. Table 3.1-30 shows blast injuries to humans and structural damages in relation to distance from the explosion. The fire ball radius for a 159 ton TNT equivalent would be 43 feet. Second-degree burns would occur at 500 feet with first-degree burns expected at 800 feet.

TABLE 3.1-30 159 EQUIVALENT TONS OF TNT EXPLOSION
(Worst Probable Onshore Storage Facility Accident)

DISTANCES FOR VARIOUS BLAST INJURIES

Injury	Distances (ft.) 1/
Mostly safe (whole body)	1,000
Skull fracture threshold	866
Fracture feet and legs	800
Skull fracture near 50% probability	733
Lethality threshold (whole body)	693
Skull fracture near 100% probability	653
Lethality near 50% probability (whole body)	600
Lethality near 100% probability (whole body)	533

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCTURES

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
1. Wood-frame building	1,500	975
2. Multistory, wall-bearing buildings, brick apartment house type	1,125	713
3. Multistory, wall-bearing buildings, monumental type	825	525
4. Multistory, blast-resistant design, reinforced-concrete buildings	345	225
5. Multistory, reinforced-concrete buildings, with concrete walls and small window area	600	390
6. Highway truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	375	240
7. Multistory, reinforced-concrete, frame office type buildings, earthquake resistant	375	240
8. Light steel-frame industrial buildings	525	315
9. Heavy steel-frame industrial buildings (25- to 50-ton crane)	450	278
10. Heavy steel-frame industrial buildings (60- to 100-ton crane)	413	255
11. Railroad truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	413	255
12. Multistory, reinforced-concrete frame office type buildings	413	255
13. Highway and railroad truss bridges of 250- to 400-foot span (blast normal to longitudinal bridge axis)	413	255
14. Multistory, steel-frame office type buildings	353	225
15. Multistory, steel-frame office type buildings, earthquake resistant	300	195

Source: OIW 1979 (Rev.)
1/ After correction for surface/air burst.

A further refinement of damage estimates from a storage tank explosion, which allows comparison with explosion consequences reported in chapter 8, is described below.

Causes for Variations in Blast Effects

Distances given for explosion damages are not absolute. Structural damage and injuries can occur outside the estimated limits due to focusing effects on the blast wave by structures and topography. Explosion forces exerted upon structures depend on the duration and over pressure of the blast wave. When a blast wave passes a structure the reflected over pressure is often greater in magnitude than the incoming initial blast wave. This reflected overpressure causes the most structural damage. Focusing from another structure or topography can increase the reflected over pressure and duration of the blast wave. Also negative focusing, or degradation, can lessen the blast effects.

Differences in atmospheric conditions (such as wind speed and direction, temperature, and moisture) can also affect focusing and reflection of blast waves and result in damages at greater distances from an explosion than indicated in the preceeding tables.

POSSIBLE STORAGE TANK EXPLOSION CONSEQUENCES

Type of Damage	Radial Distance (feet)
Human Casualties:	
Mostly safe	920
Lethality threshold	675
Lethality near 50% probability	623
Lethality near 100% probability	572
Structural Damage:	
Wood Frame	
Scattered	3,884
Moderate	1,942
Severe	1,431
Brick, Multistory	
Scattered	3,884
Moderate	1,635
Severe	1,226
Light Steel Frame Industrial	
Scattered	3,884
Moderate	664
Severe	460

Source: OIW 1979

AIR QUALITY

This section describes the impacts on air quality expected during construction, operation, and abandonment of the proposed project. Projected pollutant emission figures are presented for each phase. Then, effects on air quality levels are predicted using mathematical models.

Construction Phase

Port Facility

Pollutant emissions during construction of the port facilities at Port Angeles would result from operation of construction equipment and vehicles. Emissions of nitrogen oxides, carbon monoxide, hydrocarbons, sulfur dioxide, and particulates were determined from EPA emission factors given in the AP-42 manual (EPA 1977). Emission rates in table 3.1-31 represent the maximum expected rates in an 18-month construction period. Since the type and number of construction equipment operating at the site would vary from day to day, emissions would usually be lower than those in table 3.1-31. Much of the activity would be either on the water or at the shoreline, so fugitive dust emissions would be negligible.

TABLE 3.1-31 EMISSIONS ESTIMATES FROM CONSTRUCTION OF PORT FACILITY

Pollutant	Emissions (lb/working day)
Nitrogen oxides	3,300
Carbon monoxide	1,500
Hydrocarbons	460
Sulfur dioxide	220
Particulates	150

Source: SAI 1978

Emissions expected with construction of the submarine pipeline are listed in table 3.1-32. Construction would take place over a 3-month period. The figures represent maximum rates; usually, emissions would be less.

Impacts on ambient air quality would be confined to the construction site; concentrations would be well within federal and state air quality standards. No impacts would be expected for residential areas in Port Angeles. Pollutant levels would not be sufficient to adversely affect public health.

TABLE 3.1-32 EMISSIONS ESTIMATES FROM CONSTRUCTION OF SUBMARINE PIPELINE

Pollutant	Emissions (lb/working day)
Nitrogen oxides	3,380
Carbon monoxide	1,000
Hydrocarbons	240
Sulfur dioxide	230
Particulates	150
Fugitive dust	1,100

Source: SAI 1978

Onshore Storage Facility

Emissions resulting from construction activities at the site of the proposed Green Point storage facility are shown in table 3.1-33. In addition to emissions from combustion engines, disturbance of the soil would generate fugitive dust. Fugitive hydrocarbons from spray painting the tanks would be highest during the first 12 months of the 18-month project. Dust could be a nuisance in the construction area.

TABLE 3.1-33 EMISSIONS ESTIMATES FROM CONSTRUCTION OF ONSHORE STORAGE FACILITY

Pollutant	Emissions (lb/working day)
Nitrogen oxides	1,140
Carbon monoxide	280
Hydrocarbons	80
Sulfur dixoide	75
Particulates	55
Fugitive dust	10,800
Fugitive hydrocarbons	600

Source: SAI 1978

The sporadic nature of construction activities and changing weather conditions make prediction of pollution levels difficult. However, it is expected that no federal or state air quality standards would be violated. Impacts on air quality would be limited to the immediate vicinity, and should not affect human health.

Operation Phase

The descriptions of impacts in this section are based on an initial throughput capacity of 709,000 barrels per day and an ultimate throughput capacity of 933,000 barrels per day as proposed by NTPC.

Predictions of air quality impacts were determined by using several different mathematical models. A model called WINDOW was used to determine the probability of various pollution concentrations averaged over 3-hour and 24-hour periods. Historical data of 5 years at a national weather station on Ediz Hook were used as input to the model. It helped determine particular meteorological conditions that would lead to highest concentrations.

These worst-case meteorological conditions were used as input to a more refined model, the Texas Episodic Model (TEM), to determine the combined effects of emissions from the proposed project and major existing emission sources in Port Angeles. Results of this model were used to determine compliance with the Federal and state air quality standards. An EPA developed model, VALLEY, which takes into account variable topography, was also run to obtain a conservative estimate. Annual average concentrations were calculated by using the Texas Climatological Model (TCM).

The impacts from the modeling described in this section must be viewed as representing only preliminary estimates. Lack of extensive meteorological and air quality monitoring data in the Port Angeles area makes quantitative air quality projections difficult. Furthermore, dispersion models themselves represent only approximations as they are based on a number of simplifying assumptions. A more refined modeling analysis can be performed once on-site monitoring data, presently being collected by the applicant, are available.

The following sections describe the modeling results for each pollutant. First, the emissions are presented and then pollution concentrations as determined from the models are given and compared with applicable air quality standards. Below, the first section deals with tanker stack emissions; the second deals with potential effect on ozone levels of hydrocarbon emissions.

The pollutants present in tanker stack gases are sulfur dioxide (SO_2), oxides of nitrogen (NO_x), particulate matter, hydrocarbons (HC) and carbon monoxide (CO). Rates of emission of these pollutants would depend on the ship's engines and, in the case of SO_2, on the sulfur content of the fuel. While in port, ship's engines would normally be operating at about 10 percent of full load to provide heat and electricity onboard. The engines would also be used to drive the pumps which unload cargo to onshore storage tanks and to load water into the ballast tanks. Such pumping operations usually employ the engines at full load for 12 to 24 hours for unloading and for about 3 to 5 hours for ballasting. During these periods SO_2, NO_x, and particulate emissions are greatest.

NTPC would require all tankers to burn No. 2 diesel fuel with a maximum sulfur content of 0.45 percent while unloading. Steam-powered vessels normally use residual fuel oil, commonly known as "Bunker C" fuel. This fuel has a highly varied sulfur content, ranging between 1 and 5 percent, and averaging between 2.5 and 3.0 percent (Pacific Merchant Shipping Association 1977).

Diesel powered vessels use No. 2 diesel fuel with a sulfur content of less than 0.5 percent. Although some of the larger tankers are diesel-powered, the majority of the world fleet consists of steam powered vessels (Goodrich et al. 1974).

Because of the intermittent nature of ship arrivals, a queuing model was developed to determine the probability of various sizes of ships occupying the proposed two-berth port. Table 3.1-34 shows the frequency and duration of tanker visits by dead weight tonnages for the ultimate 933,000 barrels per day capacity. Results of the queuing model were used to estimate frequency of various emission rates.

TABLE 3.1-34 ESTIMATED FREQUENCY AND DURATION OF TANKER VISITS (933,000 bpd)

Crude Oil Source and Ship Size (dwt)	Visits/Year	Duration of Visit (hours)
North Slope Crude		
50,000	74	24.0
70- 80,000	134	24.0
120-130,000	53	24.0
165,000	21	24.5
190,000	8	26.5
Foreign Crude		
100-125,000	5	24.0
150-175,000	34	24.5
175-200,000	17	26.5
200-225,000	17	28.0
225-250,000	16	30.0
300-327,000	16	36.2

Source: SAI 1978

Table 3.1-35 shows the percentage of time emission rates would exceed various values. Emissions for tug boats were obtained by assuming they would burn diesel fuel with a sulfur content of 0.275 percent.

It was assumed that prior to docking, ships would burn fuel with an average sulfur content of 2.0 percent, and that ships would burn diesel fuel with a sulfur content of 0.45 percent while unloading, ballasting, hoteling, and deberthing.

TABLE 3.1-35 ESTIMATED TANKER STACK EMISSION RATES 1/

	Emission Rate (lb/hr)		
Percentage of time	Sulfur Dioxide	Nitrogen Oxides	Particulates
50	144	75	32
25	228	116	47
10	279	152	65
1	351	192	83
0	367	205	88

Source: SAI 1978
1/ Throughput of 933,000 bpd.

Yearly emissions determined from the estimated number of tanker visits are given in table 3.1-36. Stack emissions of hydrocarbons and carbon monoxide are small compared to the other pollutants and would not cause any significant impacts. Emissions of sulfur dioxide, particulates, and nitrogen oxides were considered in the modeling calculations to determine impacts described below.

TABLE 3.1-36 ESTIMATED YEARLY TANKER STACK EMISSIONS 1/ (Tons)

	709,000 bpd	933,000 bpd	Existing Port Angeles Sources 2/
Sulfur dioxide 3/	467	615	4,472
Nitrogen oxides	247	325	2,835
Particulates	84	110	1,568
Hydrocarbons	15	20	1,105
Carbon monoxide	12	16	8,692

Sources: 1/ SAI 1978;
2/ NTPC 1978;
3/ Based on tankers burning diesel fuel with 0.45 percent sulfur while berthed.

Sulfur Dioxide

The modeling results for sulfur dioxide are summarized in table 3.1-37. Due to the prevailing westerly winds, pollutants would tend to blow eastward over the Strait of Juan de Fuca (see Map Addendum). The highest annual average increment due to tanker emissions would be 2.0 ug/m3 and would occur about 2 miles east-southeast of the proposed port facility or about 1 mile offshore over the Strait of Juan de Fuca. This is 10 percent of the allowable Class II increment.

The area of land along the Strait east of Port Angeles would be most frequently affected. On an annual basis, the city of Port Angeles would be affected about 13 percent of the time, while the Olympic National Park headquarters would be affected about 2 percent of the time. The increase in the annual average sulfur dioxide concentration at the Olympic National Park headquarters would be less than 0.5 ug/m3 or less than 25 percent of the allowable Class I increment. On an annual basis, both the Class I and Class II incremental standards would be met.

TABLE 3.1-37 ESTIMATED SULFUR DIOXIDE CONCENTRATIONS (ug/m3) FROM STACK EMISSIONS 1/

	MODEL	Tankers Only	Class II Incremental Standards	Class I Incremental Standards	Existing Sources	Tanker Plus Existing Sources	State or Federal Ambient Standards
Annual average	TCM	2.0	20	2	28	29	53
Maximum 24-hour	TEM2/	4.4	91	5	45	45	260
	VALLEY3/	66	91	5	515	532	260
Maximum 3-hour	TEM2/	19	512	25	88	88	1,300
Maximum 1-hour	TEM2/	-		-	142	142	1,048

Source: SAI 1978

1/ Based on 933,000 bpd throughput.

2/ One 80,000 dwt and one 190,000 dwt tanker unloading simultaneously; no terrain effect.

3/ One 80,000 dwt and one 190,000 dwt tanker unloading simultaneously; terrain effects included.

For calculating short-term maximum concentrations worst-case meteorological conditions were used (table 3.1-38). These conditions were determined after examining 5 years of data for Port Angeles. For the TEM and VALLEY models, emissions were based on an 80,000 dwt tanker and a 190,000 dwt tanker unloading simultaneously. This represents an emission rate that would not be exceeded 90 percent of the time (see table 3.1-35). The VALLEY model was used to determine potential effects of the plumes interacting with the elevated terrain immediately south of Port Angeles. The model assumed light northerly winds under stable atmospheric conditions persisting for 6 hours. The 24-hour average concentration calculated by VALLEY for tanker plus existing sources exceeds the ambient air quality standard. Most of the contribution is attributed to local industrial sources. The contribution of the tankers is within Class II standards. The highest concentration occurs in the elevated terrain about a mile south-southeast of the ITT-Rayonier plant.

TABLE 3.1-38 ESTIMATED WORST-CASE METEOROLOGICAL CONDITIONS AT PORT ANGELES FOR 1-, 3-, AND 24-HOUR AVERAGING PERIODS

Average Time	Atmospheric Stability1/	Wind Speed (m/s)2/	Direction
1 hour	DD	1.5	N
3 hour	E	2.5	NNE
	E	2.5	NNE
	E	2.5	NNE
24 hour	DN	4.5	N
	DN	4.5	N
	DN	4.5	N
	DN	4.5	N
	DN	4.5	N
	DN	4.5	N
	DN	4.5	N
	DN	6.9	N
	DN	4.5	N
	DD	4.5	NNE
	DD	6.9	N
	DD	4.5	N
	DD	4.5	NNE
	DD	4.5	N
	DD	1.5	E
	DD	1.5	E
	DD	1.5	E
	DD	1.5	E
	DD	1.5	S
	DN	1.5	E
	DN	1.5	E
	DN	1.5	E
	DN	1.5	E
	DN	1.5	E

Source: SAI 1978

1/ Atmospheric stability is rated on a 7 class scale: A, B, C, DD, DN, E. A-C are unstable; DD is daytime neutral; DN is night time neutral; and E is stable.

2/ m/s = meters per second.

Table 3.1-37 shows, however, there would be occasional violations of the Class I incremental standards within the Olympic National Park. Table 3.1-39 lists the estimated frequency of Class I violations at the Olympic National Park headquarters and at the Heart O'the Hills ranger station. These estimates were calculated using the WINDOW model, modified for topographical influences. Although the national park would be infrequently affected, the impact is significant since the proposed oil port would be close to an area where incremental standards are stringent. Table 3.1-37 also shows concentrations caused by existing sources alone, and those caused by existing plus proposed sources. The contribution of the tankers would increase the annual average sulfur dioxide concentration by about 3 percent and would not be likely to have a noticeable effect on human health. The Map Addendum shows the distribution of concentrations over the Port Angeles area. The maximum 24-hour, 3-hour, and 1-hour concentrations resulting from tanker emissions plus existing emissions were found to be the same as those caused by existing sources only. This was due to emissions from the ITT Rayonier plant which were found to have maximum effect about a mile from the source, whereas the tanker emissions had their maximum effect about 9 miles downwind from the source. This resulted in very little interaction between tanker sources and existing industrial sources. (See Map Addendum.) The contribution from the tanker stacks were found to be much smaller due to the fact that the plumes rise higher, thereby reducing effects at ground level.

TABLE 3.1-39 ESTIMATED ANNUAL NUMBER OF CLASS I VIOLATIONS FOR SULFUR DIOXIDE IN OLYMPIC NATIONAL PARK

	Throughput	
	709,000 bpd	933,000 bpd
3-hour (25 ug/m3)		
Park headquarters	10	14
Heart O'the Hills ranger station	1	1
24-hour (5 ug/m3)		
Park headquarters	6	10
Heart O'the Hills ranger station	1	1

Source: SAI 1979

Particulates

The proposed project would cause a maximum increase in the 24-hour average particulate concentration of 1.0 ug/m3 which is well within both Class I and Class II standards. The increase in the annual average particulate concentration would be less than 0.2 ug/m3 which is well below the Class I standard and would not cause any health problems.

No modeling was performed for the effect of project sources combined with existing particulate sources since some of the high concentrations observed in Port Angeles are from fugitive sources which are difficult to quantify and model. Part of the commercial district of Port Angeles has been classified as a nonattainment area for particulates because of consistent violations of air quality standards (see air quality section, chapter 2).

Nitrogen Oxides

The maximum calculated 24-hour average concentration of nitrogen oxides (NO and NO_2) for project emissions combined with existing emmisions is 9 ug/m3. See Map Addendum for the concentration pattern. The maximum increase in the annual average concentration would be 0.6 and 0.9 ug/m3 for the initial and ultimate throughput capacities, respectively. Emissions from existing sources result in an annual average concentration of 4.9 ug/m3. The ambient air quality standard of 100 ug/m3, which applies only to NO_2, would be met and no health problems would be anticipated.

The average annual concentrations of nitrogen oxides for project emissions combined with existing emissions are illustrated in the Map Addendum. The maximum concentration was found about 1.4 miles east of the ITT Rayonier Plant. Results indicate that the largest contribution to the concentration of nitrogen oxides would be existing industrial sources.

Hydrocarbon Emissions

This section discusses the potential for ozone formation caused by hydrocarbon emission. Ozone results from a series of complex reactions involving oxides of nitrogen and hydrocarbons under the influence of sunlight. Tugboats and tankers would emit nitrogen oxides while operating in port. Hydrocarbon emissions would result from crude oil vapors escaping into the atmosphere while tankers without segregated ballast are unloading. Hydrocarbons would also be emitted from the proposed storage tanks at Green Point. The federal and state ambient air quality standard for non-methane hydrocarbons is 160 ug/m3 for a 3-hour average concentration between 6 a.m. and 9 a.m. However, this standard serves only as a guide in controlling ozone. The Environmental Protection Agency does not consider hydrocarbons exceeding this concentration to constitute an actual violation if at the same time the 1-hour standard for ozone of 240 ug/m3 (or 0.12 parts per million) is not exceeded. This discussion will therefore emphasize impacts from ozone.

The operation associated with the unloading of crude oil tankers that has the potential of emitting the most significant amounts of hydrocarbons is ballasting. If a tanker had separate tanks for carrying crude oil and for ballast, atmospheric emissions would effectively be zero. However, if ballast water were pumped into empty cargo tanks, the remaining hydrocarbon vapors would be displaced and forced into the atmosphere. Under normal conditions, tankers take on ballast equivalent to about 20 percent of the dead weight tonnage while in port. Under adverse weather and sea conditions, a larger percentage might be necessary. Table 3.1-40 shows the hydrocarbon emissions from ballasting for various size ships. Approximately 21 percent of the tankers would have no segregated ballast.

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TABLE 3.1-40 ESTIMATED HYDROCARBON EMISSION DURING BALLASTING OF CARGO TANKS (lbs Per Event) 1/

Tanker Size (thousand dwt)	Emission
50	2,955
70 - 90	4,727
100 - 130	6,500
150 - 175	9,602
175 - 200	11,078
200 - 225	12,557
225 - 250	14,033
250 - 300	16,250
300 - 325	18,465

Source: SAI 1978.

1/ Emission data are based on 1.1 lbs HC per 1,000 gallons of water. Assumes ballasting to 20 percent of deadweight tonnage.

There are several other operations that could emit hydrocarbons. Venting releases excess vapors that have built up in an emptied cargo tank, releasing substantially lower emissions than ballasting. It is assumed that purging, a process of flushing vapors from empty oil cargo tanks by an inert gas, would not be carried out in the vicinity of the unloading facility. This operation would only be performed in an emergency. There would be minor hydrocarbon emissions from valves and seals on the pumping equipment and the surge relief tank at the berthing facility during unloading.

Table 3.1-41 summarizes total estimated hydrocarbon emissions from the proposed port facility.

TABLE 3.1-41 ESTIMATED HYDROCARBON EMISSIONS, PROPOSED PORT FACILITY (Tons/Year)

	Throughput	
	709,000 bpd	933,000 bpd
Ballasting	227.8	365.5
Stack emissions	14.7	19.3
Valves and seals	2.7	3.5
Surge tank	0.5	0.5
Total	245.7	388.8

Source: SAI 1978

Hydrocarbon emissions from the storage tanks at Green Point would consist of standing storage losses and withdrawal losses. Standing storage losses would be vapors leaking through the seals as a result of wind-induced pressure differences. Withdrawal losses would be the evaporation of crude oil clinging to the tank shell when the floating roof descends. Both standing and withdrawal losses were calculated according to American Petroleum Institute (API) Bulletin 2517 (API 1962). Recent studies indicate that API Bulletin 2517 may significantly overestimate hydrocarbon losses (SAI 1978). Therefore, emissions from standing losses were reduced by 40 percent in the calculations. It was assumed that the crude oil would have a Reid Vapor Pressure (RVP) of 4.2 psia (pounds per square inch absolute), and that the temperature of the crude oil stored would be 75°F. The estimated yearly emission rates from the storage tanks as well as the emissions from the valves and seals and from the pump station are listed in table 3.1-42.

TABLE 3.1-42 ESTIMATED HYDROCARBON EMISSIONS (Tons/Year) FROM THE PROPOSED ONSHORE STORAGE FACILITIES

	Throughput	
Emission Source	709,000 bpd	933,000 bpd
Storage tanks	169.2	276.8
Valves and seals	15.0	24.6
Pump station	7.4	9.8
Total emissions	191.6	311.2

Source: SAI 1978

Ozone modeling was first performed for Port Angeles sources to estimate existing ozone concentrations. Modeling was then done for existing sources added to project sources, so that the change in ozone levels resulting from the proposed project could be assessed (SAI 1978). Emissions for the proposed port facility were those for a 225,000 dead weight ton tanker ballasting to 20 percent of the dead weight tonnage. Ozone levels were calculated for each hour for a 12-hour period starting at 6 a.m. with an initial ozone concentration of 0.01 ppm (parts per million) assumed.

Ozone levels were calculated for a typical summer day with west-northwesterly winds of about 10 miles per hour. Ozone concentrations in the afternoon were 0.010 ppm at Port Angeles and 0.011 ppm at Green Point. This represents about a 5 percent increase above background levels at Port Angeles, and about a 10 percent increase at Green Point.

Modeling calculations were also performed for a case with northerly winds of about 2 miles per hour in order to determine maximum impacts on Olympic National Park. Ozone levels reached an afternoon maximum of 0.011 ppm at Port Angeles and a maximum of 0.012 at Green Point. Concentrations in the Olympic National Park were less than 0.010 ppm.

A model was also used to determine whether the proposed project would cause a significant change in the ozone levels over the Seattle-Tacoma metropolitan areas since this is a nonattainment area for this pollutant. Ozone levels were determined

Plumes from several of the existing industries in the Port Angeles/Ediz Hook area. BLM along a trajectory for an air parcel originating in Port Angeles in the morning and reaching Seattle or Tacoma in the afternoon. The model results showed no change in the ozone concentrations in the metropolitan area.

Ozone modeling was also performed by Environmental Research and Technology, Inc. (NTPC 1979) for the area around Port Angeles and Sequim. Northwesterly winds with a speed of 5 miles per hour were assumed. The background ozone level assumed was 0.02 ppm. The highest ozone level in the afternoon was calculated to be about 0.04 ppm and occurred about 4 miles east of Green Point.

All modeling results indicated levels well within the federal ambient standard of 0.12 ppm. The increase above background levels resulting from this proposal are relatively small and no adverse impact on human health or welfare should occur.

Visibility

Some of the pollutants emitted from the tankers would adversely affect visibility. These are particulates as well as sulfur dioxide and nitrogen oxides, which may be transformed into particulates.

Visibility is an important parameter in defining air-quality values in Olympic National Park. The Clean Air Act Amendments of 1977 mandate a thorough review of potential impacts by the project on Olympic National Park.

On the average, the proposed project emissions would be less than emissions from existing industrial sources in Port Angeles (table 3.1-36). Therefore, most of the adverse impacts on visibility in Port Angeles and Olympic National Park would still be attributed to existing sources.

Plumes from tankers operating in the harbor area would be visible from Port Angeles, Olympic National Park headquarters, and several viewpoints on ridges in Olympic National Park. These plumes would consist mostly of condensed water vapor. Under normal operations, particulate emissions would be relatively small. Dark smoke may be visible for brief periods during soot blowing operations.

Under average conditions, no significant reduction in visual range from points within Olympic National Park would occur. However, under an extended period of light winds, sulfur dioxide in the air may be gradually transformed into sulfate particles. Sulfates contribute to visibility deterioration. Similarly, nitrogen oxides have the potential of converting into nitrate particles. A simple model was used to calculate the approximate reduction in visual range resulting from light wind conditions persisting for 24 hours. The reduction in visual range for the highest expected emission rate would be about 7 percent. However, this would not be expected to occur frequently. In most conditions, reduction in visual range would be slight and would not be noticeable.

Odor

There would be little impact from odor associated with the proposed project. The odor of sulfur-bearing compounds in hydrocarbon vapors might be detectable in the vicinity of the berths during unloading and ballasting operations. However, this would be infrequent and of short duration. Occasionally, odor might also be noticeable in the immediate vicinity of the onshore storage facility.

Fire or Explosion

A fire or explosion in the Port Angeles harbor or at the onshore storage facility would result in a large but short-term emission of air pollutants including particulates, nitrogen oxides, and hydrocarbons. Visibility would be greatly deteriorated by black smoke which could be visible for several miles, including points within the Olympic National Park.

Abandonment Phase

Port Facility

During the dismantling of the proposed port facility, emissions would be similar to those for construction (table 3.1-31). Impacts would be of a short duration and confined to the immediate dismantling site. Operations are not expected to violate any air quality standards.

Onshore Storage Facility

During the dismantling of the proposed onshore storage facilities, emissions would be similar to those for construction (table 3.2-32). Impacts would be of short duration and confined to the immediate dismantling site. No air quality standards are expected to be violated.

NOISE

This section describes noise impacts associated with the construction, operation, and abandonment of the proposed project. Noise levels were projected for receptor points such as residences, schools, and recreation areas that were near enough to be affected by the project.

Noise level predictions for a particular receptor point depend on noise intensity; the distance and barriers between source and receptor; and weather conditions such as temperature, humidity, wind direction and speed. Because of the complexity of sound propagation, noise level predictions in this statement do not take into account obstacles or wind. Calculations assumed a worst-case situation; actual noise values could therefore be expected to vary considerably over time. In addition, varying terrain and the presence of obstacles would reduce noise levels.

Noise impacts are judged with reference to two criteria. First, noise levels must conform to applicable state or local regulations. If no regulations exist, a determination is made as to whether predicted noise levels would degrade public health or welfare. Second, the increase in noise levels above existing conditions must be considered.

The addition of a given noise source would have a greater impact in an area where existing levels were relatively low than where they were relatively high. Studies have shown that persons begin to distinguish changes in noise level at approximately 5 dBA. Thus, changes lower than 5 dBA can be considered insignificant. A judgment commonly used in community noise impact analyses associates noise increases of 5 to 15 dBA with "some impact." Noise level increases of more than 15 dBA are generally considered severe.

Construction Phase

Anticipated noise impacts from construction were determined by assuming typical construction equipment for each type of operation. Since much of the same type of equipment is used in the abandonment phase, this discussion would generally apply to it as well.

Port Facility

During the construction of the proposed port facility, primary noise sources would be pile drivers, trucks, cranes, compressors, and other heavy construction equipment. Work would continue for about 18 months, mostly during the daytime.

Table 3.1-43 lists the projected noise levels during various phases of construction for locations in Port Angeles. See Map Addendum for the geographic locations for which noise level projections were made.

TABLE 3.1-43 ESTIMATED NOISE LEVELS DURING CONSTRUCTION OF PORT FACILITY

Location	Receptor	Distance From Source feet	Daytime Equivalent Noise Level, dBA						
			Existing	Predicted			Net Change		
				Piledriving	Piledriving/ Structures	Support	Piledriving	Piledriving/ Structures	Support
1	Ediz Hook parking area	500	60-61	82	83	68	+21 to +22	+22 to +23	+7 to +8
2	Crown Park	11,000	49-54	54-56	54-57	49-54	+ 2 to + 5	+ 3 to + 5	0
3	Public boat area	8,300	61	62	62	61	+ 1	+ 1	0
4	Haynes Viewpoint	8,300	63	64	64	63	+ 1	+ 1	0
5	Harbor View Park	7,100	60	61	61	60	+ 1	+ 1	0
6, 6A, 6 B	Olympic Municipal Hospital	10,000	54-63	58-64	58-64	54-63	+ 1 to + 4	+ 1 to + 4	0

Source: NTPC 1978
dBA = A-weighted sound level.

During the 10 months of pile driving operations, the severest impacts would occur on Ediz Hook. Noise levels of 82 to 83 dBA at the public recreation area on Ediz Hook would tend to discourage visitors. Noise would also be very noticeable at the U.S. Coast Guard Station. At times pile driving would increase noise in certain residential areas in Port Angeles, but would probably not be intense enough to cause annoyance.

On the shoreline at Green Point there would be noise caused by construction of a vertical slot in the bluff adjacent to the Strait of Juan de Fuca, pile driving and trench digging in the water next to the shore, and the installation of the pipe in the slot. These activities would take about 3 months. Maximum daytime noise levels experienced at the residences at the northwest corner of the proposed onshore storage facility would range between 65 and 70 dBA. At the residences near the northeast corner of the proposed facility, maximum daytime noise levels would range from 45 to 50 dBA (NTPC 1979). This would represent a significant increase above existing noise levels. Outdoor speech communication would be hampered, and residents might be annoyed by the noise increase.

Pipe pulling operations associated with the construction of the submarine pipelines would be performed on a 24-hour basis, and last a total of approximately 20 to 28 days. During this operation, residences located within 200 feet of the bluff at Green Point would occasionally experience nighttime noise levels of 45 to 50 dBA (NTPC 1979). The state noise standard of 47 dBA for nighttime operations in residential areas could therefore be exceeded. These noise levels may annoy residents and could disrupt sleep.

Onshore Storage Facility

Sources of noise during the construction of the proposed onshore storage facility at Green Point would include scrapers, bulldozers, chain saws, trucks, cranes, compressors, and other equipment. Construction would take place over a period of 18 months, generally during daytime. Table 3.1-44 shows the increase in daytime noise levels expected at some of the residential areas near the proposed onshore storage facility. The most significant impacts would occur directly west of the construction site. Equivalent noise levels between 60 and 70 dBA would be experienced by about 10 residences, while an additional 20 residences would be exposed to levels between 50 and 60 dBA. These represent maximum conditions, however, and noise levels would usually be less. Residents nearest to the construction site might be annoyed.

TABLE 3.1-44 ESTIMATED NOISE LEVELS AT VARIOUS RESIDENCES
DURING ONSHORE STORAGE FACILITY CONSTRUCTION

Location	Distance from Property Boundary (feet)	Direction	Daytime Equivalent Noise Level, dBA		
			Existing	Predicted	Net Change
1	500	East	44-48	65	+17 to +21
2	1,300	Southeast	56-62	58-63	+ 1 to + 2
3	200	West	32-36	70	+34 to +38

Source: NTPC 1978
dBA = A-weighted sound level.

Operation Phase

A fire or explosion in the Port Angeles harbor or onshore storage facility would be audible in and around Port Angeles. Noise from an explosion would also be noticeable in portions of the Olympic National Park.

Port Facility

During the operation phase the primary noise source would be two booster pumps at the unloading platform. The pumps would be electrically driven and noise effects would be limited to the vicinity of the berthing facility. With both pumps operating simultaneously, the noise level at a distance of 400 feet would be less than 55 dBA and would not be noticeable under normal conditions. Tanker operations would not cause any noticeable increase in existing noise levels.

Onshore Storage Facility

During the operation phase the primary noise source would be the electric motors at the pump station. The pumps would be designed so that the maximum noise level at a distance of 400 feet would be 58 dBA. Table 3.1-45 shows the projected day and nighttime noise levels for some of the residences near the proposed onshore storage facility. For residents living immediately to the west of the site, the nighttime noise increase would be significant and would equal the Washington nighttime noise standard of 47 dBA.

TABLE 3.1-45 ESTIMATED NOISE LEVELS DURING ONSHORE STORAGE FACILITY OPERATION

Location	Distance From Pump Station, feet		Sound Level in dBA[1/]								
			Background			Operation			Net Change		
		Direction	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
1	3,500	E	44-48	34	45-47	45-48	39	47-48	0 to +1	+ 5	+1 to +3
2	6,000	SE	56-62	39	54-60	56-62	39	54-60	0	0	0
3	1,500	W	32-36	30	37-38	47	47	53	+11 to +15	+17	+15 to +16

Source: NTPC 1978

1/dBA - A=weighted sound level

L_d = Equivalent sound level (L_{eq}) for daytime (7am to 10pm)

L_n = Equivalent sound level (L_{eq}) for nighttime (10pm to 7am)

L_{dn} = Equivalent day/night sound level defined as: $L_{dn} = ([15 \times 10^{Ld/10} + 9 \times 10^{(L_n + 10)/10}]/24)$

Abandonment Phase

See introduction to construction phase.

TOPOGRAPHY AND GEOLOGY

Unlike the other resources discussed in this document, implementation of the NTPC project would result in few impacts to the geology, nor would there be actual geologic impacts to the project. Rather, there would be potential impacts to the project that could be caused by geologic events (both human and natural), particularly those of a catastrophic nature (e.g., landslides or earthquakes). The ultimate geologically-caused impact could result in failure of some portion of the system, resulting in an oil spill. Geologic impacts, both catastrophic and noncatastrophic, would lead to impacts to other resources, particularly water quality, marine, freshwater and terrestrial organisms, and scenic quality.

Although the geologic sciences can often predict where potential exists for a catastrophic event, the time and magnitude of a landslide or earthquake cannot be predicted with any degree of reliability (USGS pers. comm. 1978).

The probability and magnitude of any event occurring during a specific period of time is based largely on the history of the event (i.e., the number of times it occurred; its magnitude; and the interval between events); the physical/chemical properties and the present condition of the material (degree and depth of physical/chemical weathering, the amount and location of stress/strain exerted on the material); and the configuration of the terrain. Although a great deal is known about the project area, there are many gaps in the geologic data base, particularly historical records of geological events. Consequently, the probability of any geologic event occurring during the 20-year life of the proposed project, and its probable magnitude, cannot be determined with any acceptable degree of reliability.

As the magnitude of most of the geologic impacts cannot be quantified, the following qualifying terms will be used whenever quantification is not possible.

Insignificant: Any geological process or event that would cause no discernible damage to the system.

Significant: Any geological process or event that would result in sufficient damage to the system to warrant repair but would not result in an oil spill.

Critical: Any geological process or event that would result in an oil spill.

Topography

Construction Phase

Because the tanker unloading berth at Port Angeles would be almost entirely waterborne, changes to topography would be negligible. On Ediz Hook, 4.3 acres would be disturbed for parking and security facilities. The 5.2-mile-long submarine pipeline from Ediz Hook to Green Point would temporarily cause limited change in the configuration of the harbor bottom, when approximately 80 acres would be disturbed for a period of up to 1 year.

Construction activities for the onshore storage facilities at Green Point would extensively change the topography of 140 acres of the 242-acre site (NTPC 1978).

Excavation for the pipeline trench from the beach to the storage facility would disturb one additional acre (estimated).

Operation Phase

Operation of the port and onshore storage facilities would have no identified impact on the topography.

Abandonment Phase

Abandonment of the tanker unloading berth and submarine pipeline would have no impact on the topography of the harbor. As the pipeline to the onshore storage facility would be trenched up the approximately 120-foot bluff at Green Point, abandonment and restoration activities would not be able to return the bluff entirely to its original configuration. Consequently, a permanent scar would remain. Abandonment and restoration of the Green Point facilities would return the onshore storage site approximately to its original topographic condition.

Physical Geology

Construction Phase

As the tanker unloading berths would be waterborne, construction of these facilities would have no impact on geologic materials. Laying of the submarine pipeline and earthwork at the onshore storage facility would involve the displacement of large amounts of geologic materials. Dredging for the submarine pipeline would involve some 1.5 million cubic yards of soft bottom sediments and 148,000 cubic yards of hard, dense marine sediments. Material remaining after emplacement and covering of the pipeline would be removed to an approved disposal site (NTPC 1979).

Excavation for the onshore storage facility (140 acres) would remove about 348,000 cubic yards of material, and grade with some 305,000 cubic yards of fill. An additional 1,200 cubic yards of material would be removed during construction of the 16 foot wide and 15 foot deep pipeline trench from the beach to the top of the 120-foot coastal bluff (NTPC 1979). About 500 cubic yards of material would be removed from the pipeline trench reaching from the top of the bluff to the onshore storage facility. The trench up the bluff would be backfilled with either grouted stone or sacked concrete after installation of the pipe. Excess material would remain on site and be blended into the surrounding terrain (NTPC 1978, rev. 3/79). Figure 3.1-4 illustrates the location of the pipeline trench up the face of the bluff. Construction activities at Green Point would change the physical characteristics of the geologic material (e.g., permeability, porosity, cementation, and moisture content), but the extent of change has not yet been determined. The erodibility of the material and the potential for slope failure would be increased (Fugro Inc. 1978).

Operation Phase

Operation of the port and onshore storage facilities would have no identified impacts on the geology.

There would be no significant impacts to topography or geology as a result of fire or explosion.

Abandonment Phase

Abandonment of the port and onshore storage facilities would have no identified impact on the geology.

Geologic Hazards

Construction Phase

Seismicity. Strong ground shaking generated by a large magnitude earthquake (6+ on the Richter scale) is the only anticipated, seismic-related geologic hazard. It could make the submarine slopes and shoreline bluffs unstable and possibly produce landslides, causing a risk to life and equipment. The probability of such an event is considered low because of the low frequency, according to historical records, of large magnitude earthquakes in the Port Angeles area and the short duration of construction.

Slope Instability. Construction activities could affect slope stability in Port Angeles harbor and coastal bluff stability near Green Point. Pile driving at Ediz Hook and excavation for the submarine pipeline could induce slope failure on the soft bottom sediments of the relatively steep (18 percent) submarine slope on the southwest side of Ediz Hook. Additional slope failure could be induced by ground shaking (either earthquake or human-induced), and by undercutting or overloading the slope. Submarine sliding or slumping has not been identified within Port Angeles harbor, and limited geotechnical studies (Shannon and Wilson 1978) in the area have indicated no evidence of such activity. However, the presence of a steep slope near the tanker unloading facilities indicates that a slope failure is possible. As the remainer of the harbor appears to have a very low gradient (generally less than 5 percent) the potential for slope failure is considered to be low.

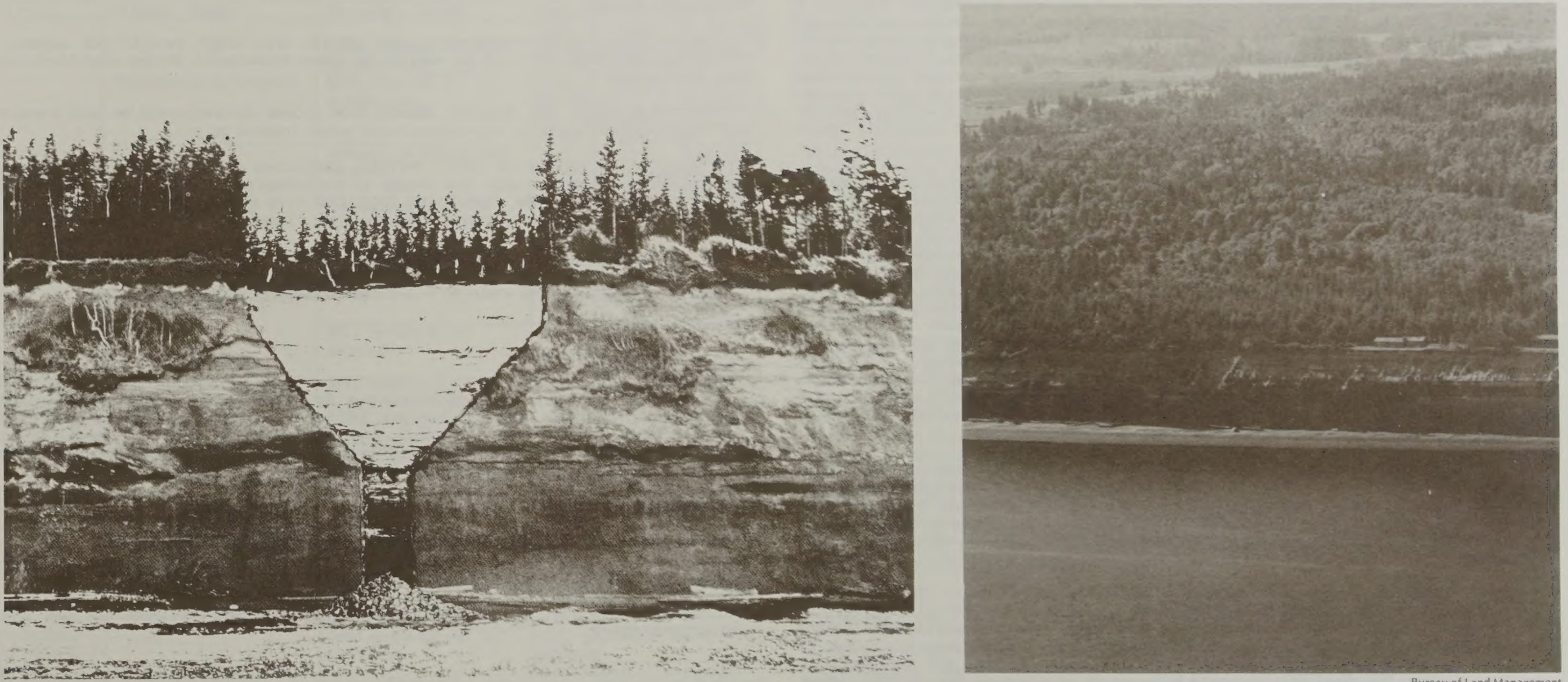
Excavation at Green Point could induce a slope failure along the potentially unstable coastal bluff (also see section 2.1 Topography and Geology) by removing support at the base. Impacts could range from minor slumping to mass movements involving several thousand cubic yards of material. Once begun, slope instability would continue, thereby endangering structures near the top of the bluffs. Until stabilization measures were instituted, impacts could include loss of life and construction equipment, as well as modification of vegetation and topography in the vicinity of the storage facility. However, a landslide is considered unlikely, as preliminary geotechnical studies (Shannon & Wilson 1978) have indicated a relatively stable condition (see section 2.1 Topography and Geology for more detail). As there is a great deal of controversy regarding the relative stability of the bluff, a more detailed geotechnical study is needed before a final conclusion is reached.

No slope stability problems at the onshore storage facility site have been identified.

Operation Phase

Seismicity. Ground shaking and liquefaction are the only anticipated, seismic-related geologic hazards that might be encountered during operation of the port and onshore storage facilities.

Ground Shaking. Strong ground shaking generated by a major earthquake in the Puget Sound region could have a critical impact on the port and onshore storage



Bureau of Land Management

Figure 3.1-4

View of Proposed Pipeline Trench up Bluff at Green Point facilities, possibly causing oil spills and/or fires. In addition, unstable slopes could fail and further damage the facilities.

Maximum Modified Mercalli intensities in the Puget Sound area are from moderate to strong (V to VIII). Seismic events have ranged in magnitude from 5 to 7.3 (Richter scale). The potential for similar levels of intensity/magnitude is high.

The potential for port facility damage or failure due to ground shaking depends upon their design. While final design criteria have not yet been established, analysis of the seismic history of the Port Angeles area indicates that the maximum expected earthquake during the life of the project would be a Modified Mercalli Intensity VII +, with an expected ground acceleration of up to 0.2g (Shannon & Wilson 1978). Therefore, the port and onshore storage facilities should be designed to withstand earthquake loads of Intensity VII +. An earthquake exceeding design criteria could occur at any time causing damage to project facilities. An oil spill, fire, or explosion could result. The probability of such an earthquake exceeding design criteria during the life of the project is low.

Liquefaction. Impacts of liquefaction of harbor sediments on the submarine pipeline would be negligible except in the case of extreme ground motions or redistribution of bearing sediments, possibly requiring the replacement of sections of the pipe and temporarily increasing sediment loads. Side slopes would not be steep enough to produce downslope movement of more than a few inches should liquefaction occur. As the pipeline would be buried in medium dense to very dense sand and gravel which is not expected to liquefy under maximum expected ground motions (0.2g ground accelerations) (Shannon & Wilson 1978), deformation of the pipeline as a result of liquefaction is considered remote and a pipeline rupture is considered unlikely; the most probable result of liquefaction would be exposure of the pipe (Fugro 1978). However, should a pipeline rupture occur, an estimated 5,000 barrels of oil per pipeline would be spilled. This includes 740 barrels spilled as a result of static head pressure, 40 barrels displaced, and up to 4,220 barrels spilled during the 2.5 minutes required to shut down the system (Fugro 1978a) based on a throughput of 100,000 barrels per hour for each pipeline.

While liquefaction could occur in the loose sands of the port area, impacts would be negligible. The pilings would be driven into dense to very dense sand and gravel deposits, which are not considered capable of liquefaction under the maximum anticipated seismic loads of up to 0.2g (Shannon & Wilson 1978). As liquified materials have very little shear resistance, they would flow around the pilings, resulting in negligible impacts.

Slope Instability. While a submarine landslide could occur, the impacts to either the port or submarine pipeline would be negligible. As the pilings for the port facility would be driven into dense to very dense sand and gravel deposits and the pipeline would be buried in the same material, deformation of these structures to the point of rupture is considered unlikely. Like liquefaction, the most probable result of a submarine slope failure would be exposure of the pipe (Fugro 1978), which might require repair. However, were a pipeline rupture to occur, the estimated size of the resulting oil spill would be the same as that discussed under liquefaction - 5,000 barrels per pipeline.

A landslide along the potentially unstable coastal bluff could cause a pipeline rupture by removing support at the base of the bluff and stress the pipeline beyond design criteria. The resulting oil spill could total 4,500 barrels from each pipeline, based on a throughput of 100,000 barrels per hour for each pipe, a 2.5 minute shutdown time after initial detection, and block valves located at the base of the bluff. As preliminary geotechnical studies (Shannon and Wilson 1978) have indicated a relatively stable slope and the applicant stated that the pipeline trench would be backfilled with grouted stone or sacked concrete along the face of the bluff with a revetment of riprap at the toe of the trench (NTPC 1978; rev. 3/79) a landslide is considered unlikely. (See also Construction Phase - slope instability).

Abandonment Phase

Seismicity. After abandonment, the impacts that might result from seismic-related geologic hazards would be similar to those encountered during operation, but much less severe.

Ground Shaking. The possible impacts from ground shaking would be less because the fluid involved would be oil-contaminated water instead of oil.

Liquefaction. Since the tanker berthing facilities at Ediz Hook would not be in use, impacts could result only from damage to the submarine lines. Again, they would be less severe because the pipes would be filled with oil-contaminated water. With the exception of a pipe rupture, impacts from liquefaction would be negligible.

Slope Instability. After abandonment, impacts that might result from slope failure would be similar to those occuring during operation, but would be less severe because the fluid involved would be oil-contaminated water instead of oil.

Mineral Resources

Construction Phase

Construction of the port and onshore storage facilities would remove approximately 242 acres of land from possible mineral extraction operations. No minerals are currently being extracted nor are there any known plans to extract minerals. The only known mineral potential of the land would be for extraction of aggregate and peat for which there are alternative sites nearby.

Operation Phase

No impacts have been identified beyond those discussed under construction.

Abandonment Phase

Abandonment of the port and onshore storage facilities might release the land for mineral development.

SOILS

Soil at the port and onshore storage facilities would be disturbed by construction, operation, and abandonment. Impacts would result from simultaneous or discrete effects of rainfall, slopes, existing vegetation, construction equipment and methods, and current land use. A reduction of soil productivity would be the end result of loss of protective vegetation, erosion of topsoil by water and wind, soil compaction, mixing of soil horizons, and soil contamination from fuel, crude oil, and less fertile fill material. There would be a total loss of soil productivity for the duration of the project in areas occupied by storage tanks, holding basins, buildings, parking lots, and roads. Table 3.1-46 summarizes impacts on the soil.

TABLE 3.1-46 SUMMARY OF IMPACTS ON THE SOIL--ONSHORE STORAGE FACILITY

Activity	Primary Impact	Secondary Impact	Possible Consequences
Earthwork (excavation, backfilling, grading, leveling, maintenance, and dismantling)	Vegetation is removed	Water erosion is accelerated	Loss of topsoil fertility
			Revegetation is impeded
			Stream sedimentation
		Wind erosion is accelerated	Loss of topsoil fertility
			Revegetation is impeded
			Dust nuisance
			Reduced visibility
	Soil profile is altered	Subsoil is mixed with topsoil	Loss of topsoil fertility
			organic matter rearranged
			Revegetation is impeded
		Contamination or dilution by other materials	Loss of fertility
			Revegetation is impeded
	Soil is compacted (density is increased)	Water infiltration is reduced	Loss of productive capacity
			Accelerated erosion
			Revegetation is impeded
		Soil aeration is reduced	Loss of productive capacity
			Revegetation is impeded
Erection of permanent structures (storage tanks, holding basins, buildings, parking lots, and roads)	Soil is covered	Soil biological activity is suspended	Soil productivity is lost
		Covered soil is preserved	
	Precipitation infiltration area is reduced	Runoff is concentrated elsewhere	Soil erosion is accelerated
			Revegetation is impeded
			Stream sedimentation
Oil leaks (construction, operation, and abandonment)	Soil is contaminated	Existing vegetation is killed or growth is stunted	Accelerated soil erosion Revegetation is impeded
		Seed germination is hindered	Soil productivity is reduced
			Revegetation is impeded
		Reclaiming might include addition of large amounts of chemical fertilizers	Contamination of ground water or streams from leached soil solution

Construction Phase

Adverse soil impacts would occur at the coastal bluff during construction of the submarine pipeline approach ramp to the onshore storage site. About 1,200 cubic yards of cliff deposits would be disturbed (NTPC 1979). Undetermined amounts of soil material would be displaced through erosion and contribute to sedimentation load of the Strait of Juan de Fuca. Littoral drift patterns would be temporarily altered.

Material excavated from the bluff and other areas would be stockpiled on the storage site for eventual re-use as berms, backfill, and grading. The stockpile would represent a potentially significant source of sedimentation since the soils would be much looser than in a natural state and the protection of vegetative cover would be absent. Quantification of this impact is not possible because surface areas and configurations of the proposed stockpiles have not yet been determined.

Soil disturbance would occur on at least 140 acres of the storage site. Environmental impacts from disturbances of the soil would generally be of two categories: 1) those that affect the soil as a medium for plant growth and, 2) those that affect runoff, erosion, and resultant sediment yield. Wet areas and peat tracts would be drained, excavated, backfilled, and compacted. Native vegetation would be destroyed, leaving the site vulnerable to wind and water erosion. Soil loss from fugitive dust (dust from construction activity) would be 1.2 tons per acre per month or 56 tons for each month of construction, assuming that one-third of the 140 acres would be undergoing construction activities at any one time (SAI 1978). This would be a loss of approximately 0.30 inch of soil for each month of construction.

Potential loss or displacement from water erosion caused by removal of protective vegetation would be 1.4 to 3.2 tons per acre per year, depending upon soils and topography. This would be comparable to normal losses on cropland in this area. Total soil loss from the disturbed area would depend upon the time that the area was void of protective ground cover and the amount and intensity of precipitation. Assuming that this period would be 2 years, the total soil loss or displacement could range from 680 to 1,540 tons. Expressed in terms of depth of surface soil removed, this would be about 0.015 to 0.35 inches (see Map Addendum). Because surface soils are more productive than the subsoils, a very slight loss of productive potential would result. Compaction of the storage site would reduce total pore space and water infiltration of areas to be revegetated. This impact would continue until topsoils were loosened by plowing or by the natural processes of freezing, thawing, shrinking, swelling, and biological action.

Operation Phase

Areas not under storage tanks, holding basins, parking lots, and buildings would be revegetated. Water-caused soil erosion would continue at much slower rates (in the range of 0.05 tons per acre per year) if the ground cover were grass, thick mulch, or similarily effective cover. Erosion on the coastal bluff would continue at about the same rate as in the past. Wind erosion would be negligible due to the protection afforded by buildings, storage tanks, and a proposed 65-foot buffer strip of trees around the perimeter. Contamination by oil spills and fluid leaks would be confined to areas within retaining dikes.

Fire or Explosion

Direct impacts from a fire or explosion would be negligible. Indirectly, destruction of vegetation by fire would increase the susceptibility of soil to water and wind erosion. Total soil loss would depend upon the size of the area burned, the amount of the cover destroyed, and the length of time ground cover is absent. Impacts from explosion would be minimal except for soil disturbance and displacement at the immediate area of explosion. Debris scattered on the soil surface would reduce soil productivity until removed.

Abandonment Phase

If buildings, storage tanks, and other facilities were left in place the impacts would be negligible. Their removal would cause impacts greater than those from initial installation because fill material would replace soil that was moved during construction. Removal impacts would occur at the locations where the fill material was obtained.

AQUATIC RESOURCES

Physical Components

This section discusses impacts to freshwater resources. Impacts to marine resources are discussed in the next section.

Construction Phase

Extensive earthwork and grading would impact the hydrologic resources at the proposed onshore storage facility site. Drainage on approximately 3 percent of the Siebert Creek watershed would be modified resulting in a 0.5 percent decrease of stream base flow. Removal of existing soil and vegetation and replacement with materials of lower permeability would decrease infiltration. Runoff would be increased by an estimated 50 percent at the proposed storage area and 95 percent at the office complex development (NTPC 1978). Sediment concentration and siltation would increase in Siebert Creek if overland flow reached the stream. Most sediment would be carried into the Strait of Juan de Fuca, where easterly currents would move it toward Dungeness Spit.

Perched and regional aquifers are reported at the proposed onshore storage facility site. Localized perched aquifers would be removed by leveling for tank construction. Recharge area of the regional aquifer could be reduced by changes in soil permeability. No significant change in ground water level is expected however, because the area of the onshore site is a minor portion of the total recharge area.

Hydrostatic test water for the onshore storage facility site and submarine pipelines would be withdrawn from the Dungeness River (NTPC 1978). Approximately 150,000 barrels of water would be required for the submarine pipelines, piping, and relief tank at the tanker unloading facilities. An additional 1.18 million barrels of water would be needed for testing the storage tanks (NTPC 1978). Preliminary hydrostatic test plans assume a river withdrawal rate of 6 cubic feet per second (cfs). At this rate filling operations would require approximately 2 weeks of constant pumping. For 39 years of record the Dungeness River discharge ranged from 68 cfs to 6,820 cfs,with a mean discharge of 394 cfs (USGS 1976). Consequently 2 weeks of constant withdrawal at the proposed rate would not be critical to river flow.

The preliminary hydrostatic test plan states that on completion of testing, the water would remain in the submarine lines to provide stability until displaced by crude oil. To control pipe corrosion, an inhibitor and bacteriacide would be added to the test water as it was pumped into the pipeline.

Before start up, the test water would be moved to holding basins, treated to reduce toxicity, and discharged into the Strait of Juan de Fuca or Siebert Creek. Water quality degradation would occur if test water were not diluted 5 to 1 to avoid toxic effects of the bacteriacide (NTPC 1978). Temperature of the discharged water might vary from the temperature of the receiving water. Assuming a 1 cfs discharge rate (NTPC 1978), temperature impact would occur for approximately 3 months in Siebert Creek.

Operation Phase

Water would be needed at the port facility for domestic use. An estimated 3,500 gallons of potable water per day would be required at the port facility. In addition up to 120,000 gallons of potable water would be supplied to each ship's tanks (NTPC 1978).

The quantity of water required for domestic purposes at the onshore storage facility would be an estimated 4,000 gallons per day. Application would be made to Agnew Fairview Water District No. 1 for water service. If necessary wells would be drilled on the site. Localized drawdown of groundwater would occur in the vicinity of the wells. High pumping rates could cause saltwater intrusion, although this has not been a major problem in this region (Noble 1960). Salt water instrusion could make well water on adjoining property unpotable. Lower well water levels would increase pumping costs.

Surface water runoff from the storage tank area would be caught in a holding basin, passed through gravity oil-water separators and coalescing filters, and then released to Siebert Creek or the Strait of Juan de Fuca. The treated water would be within Federal Water Pollution Control Act standards, however, introduction of low level hydrocarbons to the receiving waters would occur. Noticeable water quality degradation could occur over time. The discharge to Siebert Creek could result in up to a 10 percent increase of stream flow for the 1 to 2 day period required to drain the holding basin.

Dikes would retain oil from rupture of a single tank, piping, or valves within the dike areas. An unspecified seal would be used within the diked area to control infiltration of oil or oil-contaminated rainwater. If the seal were less than 100 percent effective, degradation of ground water quality would occur. Simultaneous rupture of two or more tanks would allow oil to overflow diked areas and enter the Strait of Juan de Fuca degrading water quality. The probability of this occurring is extremely low.

Abandonment Phase

Abandonment would involve removal of oil from the storage tanks and pipeline. The system would then be flushed with water to remove oil residue and combustible gases. Quantities of water equivalent to that required for hydrostatic testing would result in similar impacts to water sources. The water would be processed through the wastewater treatment system to reduce oil concentrations to acceptable federal and state levels.

Removal of tanks and storage facility piping would increase soil erosion. The exposed soil would be carried to Siebert Creek causing sediment problems in the stream until vegetation was reestablished - probably one growing season. Grading of the land surface to preconstruction contours would increase baseflow of Siebert Creek. Replacement of materials of low permeability with native soil would increase infiltration and percolation of water to ground water, increasing the recharge area of the aquifers.

Biological Components

Construction Phase

Minor amounts of sediment associated with runoff and erosion could reach Siebert Creek prior to the construction of containment dikes and revegetation around the cleared area. Since only minor amounts of sediment would be anticipated, fishery resources in Siebert Creek should not be significantly impacted.

Impacts related to hydrostatic testing are discussed in section 3.2 Biological Components.

Operation Phase

Oil-water separators would process surface water runoff within the diked area at the onshore storage facilities prior to discharge into Siebert Creek and the Strait of Juan de Fuca. It is likely that the effluent would contain hydrocarbons, but it is not known what the concentration would be. Since the discharge would be required to conform to water quality standards through a National Pollutant Discharge Elimination System permit, fishery resources in Siebert Creek should not be significantly impacted.

There would be no direct impact from fire or explosion.

Abandonment Phase

There should be no significant impacts on fishery resources in Siebert Creek.

MARINE RESOURCES

Physical Components

This section discusses impacts to marine environment. Impacts to freshwater resources were discussed in preceeding section.

Construction Phase

Construction of tanker berths would be expected to have short-term minimal impact on the water quality within Port Angeles harbor, the adjoining Strait of Juan de Fuca, and Dungeness Spit. Pile driving would disturb and suspend finer surface sediment fractions (silts and clays). Some turbidity in the vicinity of the berth could be expected.

Approximately 775,000 cubic yards of marine sediment would be displaced by dredging and jetting or dredging and plowing methods for each pipeline. The consistency of the displaced sediments would range from loose, silty, fine sand with scattered shell and wood fragments to occasional layers of soft clayey, organic silt. The thickness of this upper sediment layer varies from 0.5 to 1 foot offshore of Green Point, to 11 to 16 feet near the proposed berths. Below these recently deposited sediments are hard, dense marine and glacial sediments (NTPC 1978). Water quality could be significantly degraded for 38 to 40 days during trenching operations for the submarine pipelines.

Trenching operations for the two pipelines would suspend the fine-grained sediments, resulting in turbid water conditions. Tidal currents would transport the suspended material into Port Angeles Harbor and towards Green Point, as shown in figures 2.1-7 to 2.1-10. Westerly winds could cause the turbid plume to drift in to Dungeness Spit. Very fine silts and clays have very long settling velocities. These turbid marine water conditions could persist for some time due to the slow turnover rate in the harbor.

The plume would also extend into the Strait of Juan de Fuca. Turbulence would maintain the fine sediments in suspension, and estuarine and tidal currents would tend to move the plume seaward.

Sulfides, associated with the fine-grained sediments, could lower the marine water acidity, exert a chemical oxygen demand and could cause an odor problem. Organic material could also reduce dissolved oxygen in the water. Displaced material could contain heavy trace metals such as mercury, cadmium, and silver, as well as petroleum hydrocarbons, phosphates, and chlorinated hydrocarbons such as DDT, dioxin, and biphenyls. These contaminants would lower local water quality for several months. The lowered water quality could change the water use classification of Port Angeles harbor and adjacent waters of the Strait of Juan de Fuca from the present excellent conditions to fair conditions. This degradation could extend eastward to Dungeness Spit. Those marine resources that would be affected should the water classification change would be commercial and recreational fishing.

Operation Phase

Fire or Explosion

A tanker fire or explosion could result in an oil spill, the impacts of which are described in the following pages.

Transhipment of crude oil entails a risk of spillage. Spills can occur from tankers while in transit or at berth, from marine pipelines, from onshore storage facilities, and from terrestrial pipeline systems (including pumping stations and delivery stations). Assessment of risk involves estimating the frequency of spills, predicting the oil spill trajectories, and estimating the size of spills. (See section 3.1 for estimated size of spills.)

In-Transit Spills

Hypothetical casualties were considered to occur off Neah Bay, west of Clallam Bay, and off Port Angeles. A computer model was used to generate oil spill trajectories at each site. Each trajectory is the movement of the center of a hypothetical oil slick and does not include an estimate at a specific spill volume. The computer model identified probable spill impact zones and estimated the elapsed time to landfall (Steward 1978).

The tabulated impact zones are at best qualitative estimates as to the most probable point of first impact of an oil spill. Instantaneous small spills at each site can be expected to come ashore somewhere in the zone. Oil spills that occur over long time intervals, such as the Argo Merchant or the Amoco Cadiz oil spills, can be expected to impact most of the shoreline within these zones.

It should be emphasized that the trajectories did not include all known oil spill transport mechanisms. Oil spreading is not included nor coastal transport of oil from the original impact point. After the first beaching of oil, part of the oil spill would be refloated on the next flood tide and thus be transported to another area. This alongshore transport of oil from the original beaching site can be expected in the Strait (Stewart 1978).

The oil spill trajectory figures in the Map Addendum incorporate the oil transport processes in the computer model, and other transport processes such as spreading, wave action, and littoral currents. The boundary zones are given by the shaded areas and were primarily determined by the geographical extremes of the trajectories generated at each site. The impact zones in the figures are qualitative and should not be considered absolute since spill size is not included (OIW 1979).

Off Neah Bay. Hypothetical oil spill trajectories from a casualty off Neah Bay and qualitative impact zones for March and September conditions are shown in table 3.1-47. Although trajectories terminate off Cape Flattery, oil spills could impact the outer coast. During spring conditions the California Current could transport the oil southward to Grays Harbor. During winter the Davidson Counter-current would probably transport most of the oil northward to the coast of Vancouver Island.

TABLE 3.1-47 PROBABLE IMPACT ZONES FOR SPILLS OFF NEAH BAY

Conditions	Zones	Shoreline (nautical miles)
March	Magdalena Point to Jordan River (Canada)	22
	Seal/Sail Rock to Cape Flattery	7
	Cape Flattery to Grays Harbor	103
September	Owens Point to Clo-oose (Canada)	15
	Barkley Sound to Cape Scott (Canada)	96
	Seal/Sail Rock to Cape Flattery	7
	Cape Flattery to Cape Alava	16

Source: Stewart 1978; Oceanographic Institute of Washington 1978

West of Clallam Bay. Oil spill trajectories for a hypothetical tanker casualty west of Clallam Bay near Sekiu are shown in table 3.1-48. Most likely zones of first oil impacts in March are from Sombrio Point to Sheringham Point, Canada and from Seal Rock/Sail Rock to Cape Flattery. In September the most likely initial impact zones are from Carmanah Point to Owens Point, Canada and from Seal Rock/Sail Rock to Pillar Point. The terminated open water trajectories west of Cape Flattery would be expected to be influenced by the California Current and Davidson Counter-current. Thus oil spill impact zones on the outer coast could be from Owens Point to Cape Scott, including Barkeley Sound, Canada and from Cape Flattery to Cape Alava.

TABLE 3.1-48 PROBABLE IMPACT ZONES FOR SPILLS WEST OF CLALLAM BAY

Conditions	Zones	Shoreline (nautical miles)
March	Sombrio Point to Sheringham (Canada)	17
	Seal/Sail Rock to Pillar Point	20
September	Carmanah Point to Owens Point (Canada)	11
	Owens Point to Cape Scott (Canada)	100
	Seal/Sail Rock to Pillar Point	20
	Cape Flattery to Cape Alava	16

Source: Stewart 1978; Oceanographic Institute of Washington 1978

Off Port Angeles. In-transit tanker casualties were assumed off Port Angeles for March and September. The impact zone for March conditions is from Pysht to Dungeness Spit; for September conditions, the regions of first oil impact are Beechey Head to Cape Calver, Canada and Sekiu to Dungeness Spit, as indicated in table 3.1-49. The computer model did not include movement of spills directly across the

Strait of Juan de Fuca. Weak transverse estuarine flow has been observed, which could transport spills off Port Angeles to landfalls near Rocky Point. Thus, the impact shown in the Map Addendum was enlarged to consider this movement (Stewart 1978).

TABLE 3.1-49 PROBABLE IMPACT ZONES FOR SPILLS OFF PORT ANGELES

Conditions	Zone	Shoreline (nautical miles)
March	Pysht to Dungeness Spit	46
September	Beechey Head to Cape Calver (Canada)	7
	Sekiu to Dungeness Spit	61

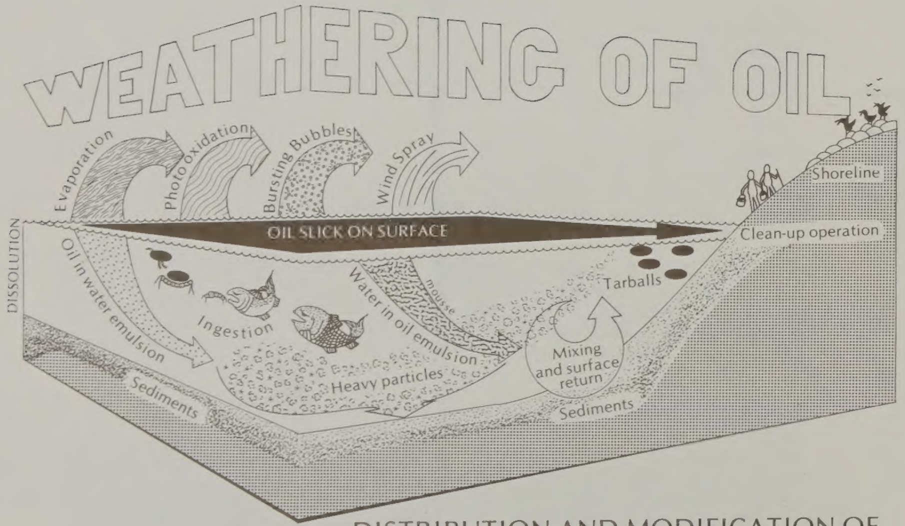
Source: Stewart 1978; Oceanographic Institute of Washington 1978

Harbor Spills

Movement of oil spills near the entrance to Port Angeles harbor would depend on the tidal cycle at the time of spillage. Oil spills occurring on the ebb tide would be expected to be transported into the harbor by the dominant clockwise eddy, as shown in figure 2.1-7. Spills just outside the harbor entrance would be transported easterly towards Green Point. Oil spilled during the onset of flood tide would be transported easterly and towards the shore as shown in figure 2.1-8. A spill occurring during the ensuing ebb tide would transport the oil into the harbor and towards shore. Spills outside the harbor would be transported westward into the Strait, as shown in figure 2.1-9 (Tollefson 1971; Oceanographic Institute of Washington 1978). Prevailing westerly winds in the vicinity of the harbor might retard the transport of oil into the harbor, but the spill would probably impact Green Point and Dungeness Spit (OIW 1978).

Marine Pipeline Spills

Rupture of one of the submarine pipelines could release up to 5,000 barrels of oil. If one pipeline were ruptured and the pressure decayed almost instantly, the system would shut down within 2.5 minutes in response to pressure loss. Oil would spill into the harbor. Seawater would slowly leak into the broken ends of the pipeline and displace some oil. As sea water filled the pipe, the oil would be trapped in the line. The volume of the most probable spill is calculated in table 3.1-50 below.



DISTRIBUTION AND MODIFICATION OF PETROLEUM AT SEA

TABLE 3.1-50 VOLUME OF OIL SPILLED FROM PIPELINE BREAK

	Volume (barrels)
Shut down, 2.5 min.	4,220
Static-head volume	740
Displacement volume	40
Total volume spilled	5,000

Source: Fugro 1978

The oil loss volume is independent of maximum or minimum pipeline throughput and is based upon the design rate of 100,000 barrels per hour per pipeline (Fugro 1978). The oil would rapidly rise to the surface, where it would begin to fractionate into the vapor phase, dissolved phase, suspended phase, and precipitated phase. The spill in the harbor would exhibit spill trajectories similar to those described for harbor spills.

Onshore Storage Facility Spills

Spills at the onshore storage facility would probably be contained ashore. If the spill reached the harbor, it would have trajectories similar to those discussed above under harbor spills.

Weathering

Physical and chemical actions would begin as soon as the oil was released or spilled. These actions would include spreading, evaporation, emulsification, dissolution, and sedimentation. The volatile hydrocarbons would evaporate rapidly. Hydrocarbons would also dissolve and enter the water column. Oil could emulsify and form a semistable colloid called "mousse." Tar balls would form when the specific gravity of the oil surpassed that of the seawater because of evaporation and dissolution of the lighter components. Wind, waves, tides, and currents would aid in spreading these components. While the physical and chemical processes were occurring, biological processes would also be acting on the various components of the original petroleum. These processes would include degradation by microorganisms such as bacteria and uptake by larger organisms with subsequent metabolism, storage, and/or degestion. For a complete discussion of the weathering process see Mahns (1977).

Initially the evaporation rate of low molecular weight hydrocarbon is rapid. After about four days, the dissolved and dispersed volume is comparable to the evaporated volume. In general, dissolution is more than 100 times slower than natural dispersion. The slick spreading enhances evaporation (McKay and Leinonen 1977). Table 3.1-51 gives the estimated oil slick diameters. The elapsed time and spill trajectory numbers are from the computer trajectory model. The spill size is the historical average spill size for tankers in transit for eight major port systems. The model does not consider estuarine flow or tidal currents; therefore, the estimated oil slick diameters are assumed to be circular rather than elongated or patchy.

TABLE 3.1-51 ESTIMATES OF DIAMETERS OF CIRCULAR OIL SLICKS AT VARIOUS TRAJECTORY ELAPSE TIMES FROM AN 864-BARREL OIL SPILL OFF PORT ANGELES

March 1976			
Oil Spill Trajectories	Elapse Time (hrs)	Barrels of Oil in Oil Slick	Diameter of Circular Oil Slick (yds)
1	74	209	2,188
2	122	104	2,616
3	10	501	1,155
4	38	320	1,744
5	40	311	1,788
6	27	392	1,591
7	33	337	1,744
September 1977			
Oil Spill Trajectories	Elapse Time (hrs)	Barrels of Oil in Oil Slick	Diameter of Circular Oil Slick (yds)
1	53	259	2,006
2	50	270	1,984
3	66	225	2,180
4	48	296	1,962
5	45	285	1,940
6	29	354	1,591
7	25	388	1,589

Sources: OIW 1979; McKay and Leinonen 1977

Oil released into the water would diminish the availability of oxygen by exerting a biological oxygen demand. Seawater pH could initially decrease from 7.7 to 7.6, seawater temperature could increase from 49.0°F to 49.01°F, and total dissolved solids could initially increase from 29,480 mg/l to 29,580 mg/l (Fugro 1978). The dissolved fraction of oil could include minute quantities of other toxic compounds (Clark and Brown 1977; Ryan 1977; Vagnersand Mar 1972).

A submarine spill could have a greater adverse impact on water quality than a surface spill of similar size. The turbulent manner in which oil from a submarine spill would rise to the surface would increase dissolution, increase droplet formation, and would delay evaporation.

Abandonment Phase

Impacts associated with abandonment of the NTPC proposal would be similar to the risks involved during construction. The probability would exist for chronic small spills resulting from operation of equipment used in dismantling the port and onshore storage facility. If the submarine pipelines were left in place and filled with water, the possibility of a rupture of the pipeline would still exist. However, the rupture would result in the release of oily water treated with rust inhibitors. No critical impact to the marine environment would occur.

Biological Components

Impacts upon marine biological resources can be categorized as major, moderate and minor. These terms are used throughout when discussing marine biological resources. They are defined as follows: 1) major impact—40 percent or more of a population is killed, disabled or permanently displaced and/or contamination of a preferred habitat persists for more than 3 months; 2) moderate impact—15 percent to less than 40 percent of a population is killed, disabled or permanently displaced and/ or contamination of a preferred habitat persists up to 3 months; 3) minor impact—less than 15 percent of population is killed, disabled or permanently displaced and/or contamination of a preferred habitat persists for less than 1 month.

Construction Phase

Impacts from the construction of the port and installation of the submarine pipeline would be concentrated in Port Angeles and Green Point. Overall impacts upon benthic animals, plants, and fish are expected to range from minor to moderate, with three exceptions.

Clams would be destroyed during port construction because of increased sedimentation and suspension of toxic materials. Contaminated clams could be unfit for human consumption. Clam beds would be contaminated for many months. Impacts to clams would be major. Reduced oxygen levels and suspension of toxic materials could also have a major impact on surf smelt spawning in Port Angeles harbor.

Operation Phase

A tanker fire or explosion would not directly cause significant impacts. However, an oil spill resulting from a tanker fire or explosion accident would cause significant impacts as discussed below.

Impacts upon marine biological resources would result primarily from oil spills. Tables 3.1-52 and 3.1-53 illustrate some effects of oil on different habitats and groups of organisms. Oil can affect individual marine organisms by direct lethal toxicity, sublethal disruption of physiological or behavioral activities, direct coating, incorporation of petroleum hydrocarbons into the organism, and habitat alteration. The last four can lead to the eventual death of the organism. Biological damage from an oil spill can range from comparatively light to nearly total devastation (Blumer and Sass 1972; National Academy of Science 1975). Some of the factors which determine the degree of impact are:

1. physical and chemical characteristics of the oil;
2. amount of oil;
3. environmental conditions of salinity, temperature, suspended sediment, substrate, wind, tides, waves, slope of shore;
4. biological characteristics of the organism, such as species, life stage, time of year, size, and previous exposure.

TABLE 3.1-52 VULNERABILITY RANKING OF MARINE HABITATS FROM OIL SPILLS

Physical Impact		Toxicity Impact
Salt marsh	High Vulnerability	Mixed coarse
Eelgrass beds		Solid rock
Silt		Salt marsh
Mixed-fine		Eelgrass beds
Mixed-coarse		Kelp beds
Sand		Mixed-fine
Solid rock		Mud
Kelp beds		Sand
Open Water	Low Vulnerability	Open water

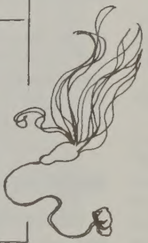
Source: Washington State Department of Ecology 1975

TABLE 3.1-53 VULNERABILITY RANKING OF MARINE BIOTA FROM OIL SPILLS

Physical Impact		Toxicity Impact
Birds	High Vulnerability	Fishes
Shellfish (mollusk)		Annelids
Echinoderms		Mollusks
Grasses		Echinoderms
Kelp		Birds
Crustaceans 1/		Mammals
Annelids		Crustaceans
Mammals 1/		Grasses
Fishes	Low Vulnerability	Kelp

Source: Washington State Department of Ecology 1975

1/ Barnacles and otters are highly susceptible to physical impact.



Impacts of Oil on Various Biological Groups

Plankton. Plankton can be subdivided into two basic groups--phytoplankton (plants) and zooplankton (animals). Anderson (1975) considers phytoplankton to be among the most sensitive marine organisms to oil. Miranov and Lanskaya (1969) and Strand et al. (1971) reported that oil generally retards the growth of phytoplankton. Miranov (1969), as cited by Miranov (1972), stated oil concentrations of 0.01 to 1,000 ppm prevented or delayed cell division and that concentrations of 0.01 to 1,000 ppm resulted in mortality. Differences occur among different species, suggesting that major changes in population structure can result from an oil spill. Studies have indicated that concentrations of crude oil necessary to inhibit photosynthesis vary depending upon physical and chemical factors, species abundance and season; very low concentrations of crude oil can stimulate photosynthesis during some seasons and high natural light levels appear to increase the toxicity of the oil.

Although impacts to phytoplankton could be major in the vicinity of a spill, expected recovery would be fast because of the rapid reproductive cycle, dispersal mechanisms, large populations, and wide distribution.

Zooplankton are also sensitive to oil (National Academy of Science 1975; Hyland and Schneider 1976; Craddock 1977). Planktonic larval stages would be particularly vulnerable to oil spills, since many are concentrated near the water surface. Oil spills could, therfore, seriously damage year classes of certain species. The grazing effect exposes plankivores to the ingested oil in the zooplankton and precipitated oil in fecal material. Lee (1975) showed that some common zooplankton can take up hydrocarbons from seawater. Thus zooplankton can pass petroleum hydrocarbons up the food chain.

As much as 40 percent of a localized zooplankton population could be killed. Recovery, however, would probably be complete within a few months, with the exception of planktonic larval stages. Death of these individuals could weaken the year class of the affected species.

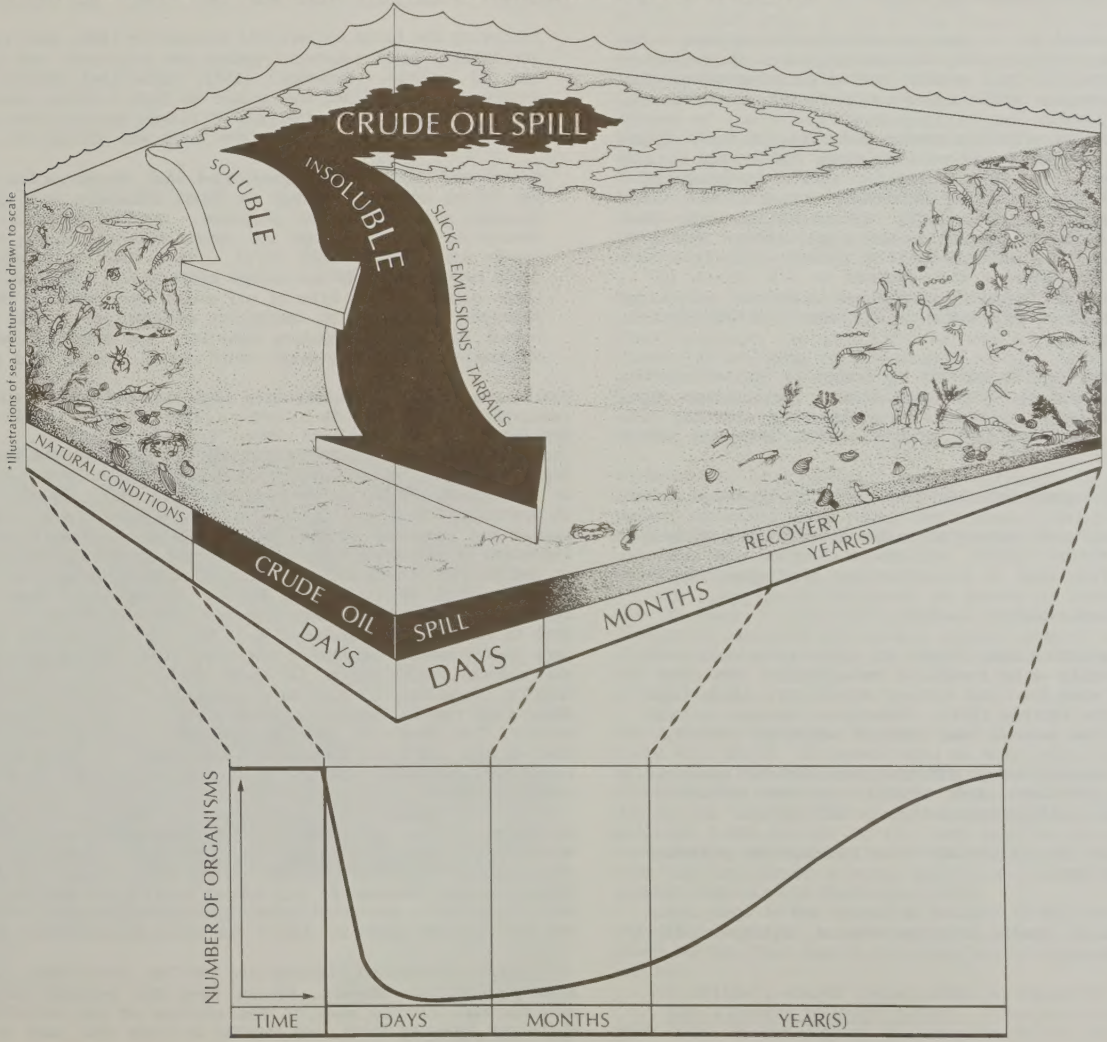
Benthos. Marine plants are usually less sensitive to oil pollution than marine animals. Benthic microflora, those tiny species living between sand grains and pebbles, are sensitive to oil pollution. Shiels, Goering, and Hood (1973) studied the effects of Prudhoe Bay crude oil on several seaweed species. They stated: "Photosynthetic response to oil-treated sea water was different for each species: Some showed inhibition at 7 ppm, while others appeared inaffected. ... Photosynthetic stimulation by crude oil was suggested for some species at low concentrations." Intertidal and shallow subtidal algae can be coated with oil, becoming over-weighted and thus torn off the rocks (Spooner 1971). Kelp belongs to the brown algae, which have a mucilaginous covering resistant to oil. Some kelp are annuals and the reproductive stage lack this mucilaginous covering. Therefore, a spill occurring when the reproductive stage is present would result in major impacts. Oiled annuals rarely recover (Templeton 1972). The loss of a kelp bed would have a moderate to major impact upon associated species of algae, invertebrates, fish, and marine mammals.

Eel grass beds provide critical habitat for birds, fish and invertebrates. Washington's eelgrass beds are formed by Zostera, a vascular plant, not an algae. British investigators found that even small quantities of oil can weaken Zostera and make it susceptible to attacks of a parasitic fungus.

Like kelp and eel grass, salt marsh vegetation forms a basic habitat for many species. Salt marsh grass is sensitive to long-term impacts from heavy oil pollution (Baker 1971). When substantial quantities of oil soak into the base of a plant, growing points are killed. Death of the plants can result in anaerobic conditions in the surrounding mud. Lack of oxygen would greatly retard bacterial degradation of the oil.

Benthic animals are particularly susceptible to impacts resulting from alterations of their substrata. Intertidal benthos are also susceptible to smothering by oil. Chan (1973) showed that species such as acorn barnacles and limpets suffered high mortalities from smothering. Juge (1971) found no burrowing organisms in heavily oiled sediments in Santa Barbara. These animals probably died from direct toxicity. Blumer et al. (1970); Anderson et al. (1973); Lee et al. (1972), and others have shown that bivalve mollusks readily take up petroleum hydrocarbons; in some cases, massive mortalities have resulted. In cases in which clams, mussels, cockles and

EFFECT OF OIL ON THE MARINE ECOSYSTEM



*Illustrations of sea creatures not drawn to scale oysters have survived, the tissue level of petroleum hydrocarbons remained so high they were unsafe for human consumption for months to years.

Animals can be repeatedly recontaminated by oil that persists in the sediment. Lee et al. (1972) showed that California mussels would eliminate more than 90 percent of the accumulated petroleum hydrocarbons within 2 weeks if moved to an uncontaminated environment. However, these creatures are unable to move out of contaminated areas.

Sublethal effects on behavior by contamination is common in benthic animals. Exposure to crude oil can cause abnormal burrowing behavior in clams (Taylor and Karinen 1977). Feeding in starfish has been shown to be inhibited at concentrations of 1 part of oil in 10 billion (0.1 ppb) parts of water (Strevelers Worley 1975). Other workers have shown that crustaceans are particularly susceptible to behavioral effects from crude oil. Many species become narcotized and simply sink or settle to the bottom where they fall prey to other animals or are buried. Lobsters have been shown to adopt erratic behavior patterns when exposed to oil (Atema 1977). Since feeding, defense, and reproduction are partly controlled in benthic animals by chemical signals, it is possible that an oil spill could cause high mortalities.

Fishes. The effect of petroleum on the ecology of fishes is not well known. Major spills and chronic low-level pollution have most severe impacts upon eggs, larvae, and fry. Fish are more resistant to stress as adults than at other life stages. A notable exception may be anadromous fish, such as salmon, when they return to spawn.

The five most likely categories of impacts upon fish are briefly discussed below:

> Eggs and larvae could die in spawning or nursery areas due to coating or direct toxic effects. Hufford (1971), Mironov (1969), and others reported that crude and bunker oils were toxic to fish eggs in concentrations of 1 ppm. Major behavior abnormalities are reported in larvae at levels of 0.001 ppm. The larvae simply sank to the bottom and remained inactive.
>
> Adults could be killed. This would be most likely to occur as a result of direct toxic effects or indirectly as a result of maladaptive behavior. Significant mortalities occurred when coho and sockeye salmon were exposed to crude oil concentrations of 500 ppm (Morrow 1974). Behavioral changes include loss of equilibrium, inability to school, and reduced swimming activity.
>
> These behavioral changes would prevent large numbers from reaching spawning grounds as a result of avoiding petroleum, and inability to detect olfactory directional cues. Anadromous fish could be most seriously affected.
>
> Breeding populations could be lost due to contamination of spawning grounds, nursery areas, or the entrances to them.
>
> Fecundity may be changed. Shuksaker (1976) studied anchovies and striped bass. Both species have a rapid uptake of benzene into the ovaries, which markedly reduced the viability of resultant eggs.
>
> Food species may be adversely affected or eliminated, causing shifts in predator populations.

Marine Mammals. No documentation on the direct effect of oil on whales and porpoises is available (NOAA Tech. Mem. 1979). The report states:

> Following the Santa Barbara oil blowout in 1969, some popular accounts appeared attributing small cetacean (whales and porpoises) and gray whale strandings to the oil leakage. Brownwell (1971) summarized details of cetacean strandings during that period and was unable to find evidence linking these strandings to oil pollution. In the analysis of tissue samples from stranded gray whales, no evidence of excessive hydrocarbon loads was documented.
>
> Geraci and Smith (1977) speculated that stress produced by oil contamination may be an important effect on those cetaceans most sensitive to environment changes, e.g., the harbor porpoise. Another potential danger to cetaceans is absorption of oil through the mucous membrane lining the blow hole beyond the nasal plug (Norris USDI 1975). This area is always exposed to water and could become oiled during normal respiration. Eventually if penetration of the nares occurs a thin film of oil would cover much of the lungs and respiratory passages, resulting in inhibition of complete oxygen exchange, disruption of normal diving and breeding behavior, and eventual weakening of the animal. Pneumonia and probably death could result (Norris USDI 1975).

Seals, sea lions, and otters have high metabolic rates and highly developed means of insulation. The NOAA Tech. Mem. (1979) states: "Disruption of these mechanisms appears to be the immediate danger from oil pollution. ..." California and Steller (northern) sea lions, and elephant and harbor seals are insulated by blubber. Except for young pups (3-5 weeks) oil coating probably would not have a significant effect on insulation. After the Santa Barbara oil spill, LeBoeuf (1971) found no difference in mortality between oiled and unoiled elephant seal pups which had already been weaned and acquired a thick blubber layer. However, decreased food supplies or ingestion of petroleum could directly and indirectly affect metabolism. Air trapped in the fur of otters and fur seals provides primary insulation. When their fur is matted by oil it loses its ability to insulate, thus subjecting the animals to hypothermia. Kengren (1971) reported that sea otters died within hours after exposure to crude oil. Similar effects are exhibited by fur seals. Oiled fur seals are very rarely seen, supporting the view that they probably die and sink. Young of all species could suffer if their mothers were oiled while the pups were still nursing, resulting in oil being swallowed with milk. Studies of ringed seals have shown they rapidly absorb ingested crude oil. The NOAA Tech. Mem. (1979) goes on to state: "Low levels of hydrocarbons were found in body tissues and high levels were seen in bile and urine indicating rapid excretion." Geraci and Smith (1976) detected some liver and kidney damage in ringed seals. The damage did not appear significant, however.

Seals, sea lions, and probably otters have eyes that can readily be damaged by oil. Nelson Smith (1973) reported, "...after the Arrow spill, in Nova Scotia, young gray seals were found blundering about in woods, a half mile from shore, unable to find their way back because of oil around their eyes and nostrils...." The NOAA Tech. Mem. (1979) and a number of other researchers have indicated that eye damage could be the most serious potential impact for seals and sea lions as a group.

Birds. Birds and plankton are the two groups most vulnerable to oil pollution. Bird populations, however, do not have the recovery capacity of plankton. This section will discuss some of the effects of oil on birds, the susceptibility of different types of birds, and impacts on birds from past oil spills.

Oil causes the fine elements of feathers to adhere together, breaking down their capacity to insulate and repel water (Bourne 1968; Clark 1969). Tuck (1960) claimed that a 1-inch patch of oil on the breast of a murre would destroy the insulating air pocket and cause death from exposure. When plumage is moderately oiled it becomes water logged, causing birds to lose their buoyancy, ability to fly, and ability to dive (Erikson 1963; Chub 1954). Also, with the loss of insulation the bird must increase its metabolism to maintain its temperature. This is usually impossible because of its reduced feeding efficiency (McEwan and Koclink 1973). Birds attempting to clean oil off themselves ingest it. Several researchers showed ingestion of oil, in quantities comparable to what would be swallowed during preening, caused lipoid pneumonia, gastrointestinal inaction, liver malfunction, and adrenal cortical hyperplasia (McEwan and Koclink 1973). Consumption of oil-contaminated prey also leads to ingestion of oil. The combined effects of cold, starvation, disturbance, and fright lead to acute stress. This reduces the resistance to secondary infections and increases vulnerability to predation.

Egg laying has been temporarily stopped in birds when fed small amounts of oil (Hartung 1967). Viability of embryos is reduced when eggs are oiled from contaminated plumage. In addition, the behavior of many species of birds increases their chances of becoming contaminated with oil. For example, Bourne (1968a) noted that guillemots took no notice of oil until they touched it. Then, exhibiting hazard avoidance behavior, dove, resulting in total oiling. In addition to species which react to alarm by diving, other behavior patterns are: plunging, and surface seizing feeding methods, surface roosting, night roosting, and flocking.

Estimates of bird mortalities are difficult because most dead birds sink or are eaten. Jones et al. (1970) and Tanis and MarzerBruyns (1968) estimated that 50 to 90 percent of oiled birds never reach shore. Other workers conducted experiments with dead birds and found only about 20 percent came ashore within 4 months.

Harbor seal

U.S. Fish and Wildlife Service

Specific Area Impacts

For purposes of discussion, all of the potential oil spill impacts upon marine biological resources will assume a spill size of 1,000 barrels and an arrival time of 2 days. See section 3.1 Oil Spill, Fire, and Explosion Risk Analysis for frequency and magnitude. The impacts described below could be much more severe in the case of a larger spill.

The arrival time of two days is used because modeling showed an average arrival time to be 46.6 Hours. It should also be note, with respect to the selection of 1,000 bbl spill size, that the average spill size of all spills in Greater Puget Sound between 1973-1976 was 4.9 barrels/spill while the average for the eight major U.S. ports during the same period was 217 barrels/spill (U.S. Coast Guard 1978). Therefore, although 1,000 barrels is far less than the maximum credible spill size it is far larger than average spills in the eight major U.S. oil ports, and slightly larger than the calculated average spill size of 864 barrels for this proposal (Oceanographic Institute of Washington 1978).

The following is a brief discussion of the possible impacts from Cape Flattery to Grays Harbor; Neah Bay to Port Angeles; Port Angeles; Green Point; and Dungeness Spit and Bay.

Cape Flattery to Grays Harbor. A project-related oil spill would probably occur just north of the Cape at the entrance to the Strait of Juan de Fuca. This area is characteristically rough. Assuming a medium sea state, over 40 percent of the oil would evaporate within the first 24 hours. Moderate to major impacts could occur at Tatoosh Island and the Flattery Rocks National Wildlife Refuge. Oiling of numerous offshore rocks and islets would kill moderate numbers of organisms. The normally rough water would help mitigate intertidal and shallow subtidal impacts by cleaning the rocky areas. The most seriously impacted would be the sea birds. Eight species have critical habitat in this area (Washington Department of Ecology 1977). Major impacts could occur to the tufted puffin, common murre, pelagic cormorant, Brandt's cormorant, widgeon guillemot, and glaucous winged gull. Minor to moderate impacts could occur to Thayers gull and the black oyster catcher.

Anticipated impacts to Steller sea lions and harbor seals would be minor. Impacts to river and sea otters would be major because of dependence on their fur for insulation.

Impacts on other marine biological resources would be minor.

South of Cape Flattery and Tatoosh Island are important river-estuary and salt-marsh habitats at the Waatch and Sooes Rivers and Makkaw Bay. If an oil spill contacted these estuaries and salt marshes, impacts could be major and contamination could last for many years. Anadromous fish using these rivers could be forced away in an attempt to avoid the oil or confused by olfactory interference from the oil.

Impacts upon birds with critical habitat at Quillayute Needles National Wildlife Refuge are expected to be major. The species are western grebe, double crested cormorant, white winged scoter, surf scoter, and Cassin's auklet.

Oil reaching Grays Harbor would have had additional time to evaporate, dissolve, and weather. Therefore, impacts should be less. If substantial amounts of oil entered the harbor, even in a weathered state, major impacts would occur to tide flats and associated shellfish, to the marsh, and to shrimp and crab fisheries as well as to the glaucous winged gull, common murre, and rhinoceros auklet. Other species with critical habitats in Grays Harbor would probably suffer moderate impacts. These include English sole, starry flounder, green sturgeon, white sturgeon, American shad, black brandt, mallard, pintail, canvas back, red knot, and chenlin.

For this entire section of the outer coast it should be noted that currents tend to move northward in the late fall and winter. Therefore a spill occurring at the Cape or in the Strait during this time of year would probably not reach the areas just described. Also, due to the distances involved, only a spill of many thousand barrels would contaminate this large section of coast to a significant degree.

Neah Bay to Port Angeles. Within this stretch of coastline the most vulnerable biological areas are Neah Bay, Pysht River estuary, Low Point, and the Elwha River estuary. Impacts upon seals at Waadah Island and Low Point would probably be moderate, based upon habitat contamination. Disabling eye injuries could also be sustained. River otters could sustain major impacts. Impacts to birds using these areas would be moderate. The intertidal clam bed in Neah Bay, the Pysht River, and Elwha River estuaries-salt marsh-sand flat areas could sustain major impacts. Clams that survivied the initial oiling could be recontaminated for several years. Most of the large bottom fish populations would suffer minor impacts. Pacific halibut could suffer moderate impacts. Anadromous fish would suffer minor impacts unless the spill occurred when the fish were beginning their migration upstream, or the smelt were going to sea. In these cases impacts could be expected to be moderate for the particular stream involved.

Port Angeles. Surf smelt would suffer major impacts from an oil spill. It is possible that this species could be displaced from Port Angeles due to construction impacts and low level chronic pollution or oil spill. Clams would suffer major impacts. Clams would not be displaced but could experience substantially reduced productivity with resulting population declines and long term contamination. Crabs would have minor to moderate impacts from chronic pollution or a spill. An oil spill and or chronic pollution could have moderate impacts upon Pacific halibut. Other fin fish are anticipated to sustain minor impacts. Harbor seals and river otters may suffer major impacts. Chronic low level pollution could displace these animals from the Port Angeles areas.

Tidal flat, estuary, mud, and mixed fine habitats, critical for many birds, could suffer major impacts. The effect upon the birds would be moderate.

Green Point. Chronic low level pollution from Port Angeles as well as possible spills near Green Point would impact the marine resources off Green Point. The major construction and operation impacts would serve to substantially reduce the number and availability of clams. Operation impacts upon most other species would be minor. Those species that are directly or indirectly dependent upon the clam beds could, of course, sustain more serious impacts. An oil spill could have a major impact on the red necked grebe.

Dungeness Spit and Bay. The extensive sand and mud flats, marsh, and eel grass beds, and all dependent flora and fauna could suffer major impacts. Recovery times for the mud flats and marsh could be as long as 10 years. Eel grass is vulnerable to low level oil pollution as well as to large spills.

An oil spill could have a major impact upon geoducks. Pacific oysters are cultured here and could also experience major impacts. Crabs could suffer moderate to possibly major impacts while impacts on octopus are expected to be moderate.

Major impacts are expected for surf smelt and moderate to minor impacts are expected for Pacific halibut species, respectively. Other fish in this area would probably sustain minor impacts.

Harbor seals and river otters could suffer major impacts. Of 21 bird species at least 12 would be expected to suffer major impacts.

If a 1,000 barrel or larger oil spill hits this area, the biological character could be substantially altered for a minimum of 10 years.

Endangered Species

Three endangered species, the fin, gray and humpback whales, are occasionally sighted in the region. As discussed previously, virtually nothing is known about the effects of oil on whales. The proposed project could impact these animals, and any reduction in populations would have a serious effect on the species. However, it is not antipated that the proposed project would severely impact the species, due to their rare occurrence within the Strait of Juan de Fuca and Puget Sound.

Abandonment Phase

Impacts associated with abandonment of the NTPC proposal would be similar to the risks involved during construction. If the pipelines are drained of oil, left in place, and filled with inert material, no significant impacts are anticipated.

TERRESTRIAL VEGETATION

Construction Phase

About 4.3 acres of land on Ediz Hook would be required for port facilities. An estimated 15 additional acres of construction right-of-way would be required for the double pipeline to the tip of the Hook. Therefore, about 19 acres of thin, grassy vegetation would be cleared on Ediz Hook.

Approximately 140 acres of forest on the 242-acre storage facility site would be removed during construction and could not be reestablished through the life of the project. This loss of vegetation would be of relatively minor significance since the existing forest was previously logged, is not a mature stand, and is of a type widespread in the region.

No plant species classified as threatened or endangered are known or likely to occur on either Ediz Hook or the Green Point site.

Operation Phase

During project operation adverse vegetation impact resulting from emission of pollutants to the atmosphere, oil spills, and fire could occur as discussed below.

Emission from the port facility and ships in port would include hydrocarbons, nitrogen oxides, and sulfur dioxide which can be toxic to plants. Maximum short-term sulfur dioxide concentrations could produce vegetative injury. The annual average sulfur dioxide levels are already potentially harmful to lichens. Average annual sulfur dioxide level predicted for park headquarters is near the threshold where long-term chronic injury to lichen could begin. Plant injury by sulfur dioxide outside the immediate Port Angeles area is highly unlikely.

Worst-case ozone concentrations east of Port Angeles during operation could approach the level where chronic, prolonged exposure would injure sensitive plants. Worstcase conditions would be infrequent and short; plant injuries from ozone are unlikely.

Adverse impact of oil spills on terrestrial vegetation at Ediz Hook and Green Point should be minimal. Spills would probably be limited to the immediate facility sites, where vegetation would already be cleared. In the unlikely event that oil escapes the containment facilities, then oil injury to vegetation would occur as described in section 3.2 Vegetation section.

Increased risk of forest fires near the onshore storage facility is possible due to the handling of flammable materials and use of construction equipment. A fire or explosion might impact the vegetative buffer zone.

Abandonment Phase

Following project abandonment, revegetation could be difficult if soils were oily and compacted.

TERRESTRIAL WILDLIFE

Threatened and Endangered Species

Construction Phase

Removal of roosting trees on the onshore storage facility site and associated construction activities at this site would cause bald eagles to abandon the Green Point area which includes a nest site. Construction activities would also cause eagles to abandon the feeding areas along the shoreline adjacent to Green Point. Individual birds have varying limits of tolerance to disturbance which are unpredictable. However, removal of perching and roosting trees, increased noise, and increased human activity would be expected to cause eagles to relocate in habitat with less disturbance. Three to ten eagles would experience this habitat reduction. Eagle populations could decline.

Additional discussion of impacts on bald eagles is presented in section 3.2 Terrestrial Wildlife.

Operation and Abandonment Phases

Habitat changes and human activities connected with pipeline operations would probably cause bald eagles to avoid the Green Point area throughout the project life. This avoidance would probably continue after project abandonment.

Other Species

Construction Phase

Construction of the onshore storage facility would cause the variety of wildlife (identified in section 2.1 Terrestrial Wildlife) inhabiting and frequenting the Green Point site to relocate to other areas where more suitable habitats were available. Resulting increase in competition between those animals displaced by the storage facility and those already established in suitable habitats nearby could cause a reduction in some species populations.

Operation and Abandonment Phases

Habitat loss and human activity at the onshore storage facility would cause most wildlife species to continue to avoid the Green Point site and its immediate vicinity. Some species would likely experience a slight population reduction commensurate with the amount of habitat destroyed.

Impacts could also occur from a fire, explosion, or oil spill at the onshore storage facility. Impacts would be limited to wildlife in the immediate vicinity. Wildlife mortality could occur from thermal radiation, explosive overpressures and projectiles. An oil spill could likewise cause a short-term reduction of habitat and some wildlife mortality.

CULTURAL RESOURCES

No direct impacts to any currently known prehistoric archaeological, historical, or paleontological resources would result from construction, operation, or abandonment of the proposed port and onshore storage facilities. There would be some indirect impacts to known historical sites. The potential exists for impacts on presently unrecorded cultural resources in all project areas, especially on paleontological materials at Green Point. Shoreline archaeological and historical sites could be affected by oil spills.

Fires and explosions would not be likely to have significant direct impacts on cultural resources.

Archaeological Resources

No archaeological sites are currently known at either the proposed port or the onshore storage facility sites. No significant impacts can be definitely predicted for these areas. Potential does exist for impacts on archaeological sites which have not yet been identified.

Construction of the port and onshore storage facilities could have significant impacts on presently unrecorded archaeological sites.

Construction Phase

The potential for impacts at the port site is relatively low because of prior ground disturbing activity and because most new construction would be over the water. If any sites are discovered at Green Point, the potential for impacts would be relatively high because there would be extensive excavation and alteration of the land surface. The impact potential would also be high for any sites at off-site borrow areas and along the routes of access roads and utility corridors built to serve the storage facility. Archaeological materials could be scattered, removed, buried, or destroyed.

Any archaeological resources thus affected would be subject to a significantly adverse, one-time, permanent impact.

Operation Phase

The operation of the port and onshore storage facilities would potentially affect archaeological sites only if an oil spill resulted in oil and clean-up activities on the shoreline.

Abandonment Phase

Abandonment and dismantling impacts of the port and onshore storage facilities would depend upon construction phase impacts and the adequacy of data recovery programs carried out to mitigate construction impacts. If resources were destroyed by construction, no additional impacts would be anticipated during abandonment. The potential for impacts would be high for any sites in areas affected by ground disturbing activities for the first time during the abandonment phase.

Historical Resources

A number of historic sites are known in Port Angeles and potential exists for currently unidentified historical sites in both the port and onshore storage facility areas. Unrecorded resources could be affected directly by disturbance of sites or structures, and indirectly by alteration of the setting.

Construction Phase

The construction of the proposed port facility on Ediz Hook would be out of character with the old lighthouses and the other historic sites in the area. This visual intrusion would be a continuing impact.

At the onshore storage facility there might be unrecorded historic sites which would be affected similarly.

Operation Phase

The existence of the port facility and of tankers in Port Angeles harbor would have a continuing, indirect impact on the setting of the historical resources in the area. If an oil spill occurred in the harbor, there could be direct impacts on beach sites from the oil and clean-up activities. It is not expected that operation of the onshore storage facility would have any impacts on historical resources.

Abandonment Phase

Impacts caused by abandonment of the proposed project could be beneficial to historical resources if the facilities were removed.

Paleontological Resources

Excavations at the onshore storage facility area, especially for the submarine pipeline delivering oil from the port, could encounter fossils of Quaternary and Tertiary age. Late Pleistocene fossils could be affected by near-surface work related to onshore storage facility construction. Fossils would probably be damaged, displaced, and buried. The operation and abandonment phases of the proposed project would probably not affect paleontological resources.

VISUAL RESOURCES

Evaluations of the visual sensitivity of the proposed project sites are derived from a modified version of the Bureau of Land Management's visual resource management system, discussed in chapter 2.1 Visual Resources. The Bureau's visual contrast rating system is used to estimate impacts. This system evaluates the suitability of a proposed project for a given environmental setting. The form, line, color, and texture of the structures and other alterations are contrasted to those of the existing landforms and vegetation (table 3.2-16).

Construction Phase

The panoramic view of Port Angeles harbor would be radically altered by construction of the proposed port and support facilities on Ediz Hook. Though not differing in kind, the scale of this activity would visually dominate the existing waterfront industries--pulp mills, log storage areas, and fishing boats.

Significant visual impacts would occur as the two submarine pipelines were extended through the 120-foot sea cliff to connect with the onshore storage facility on Green Point. The clamshell dredging, the use of large trenchng equipment onshore, as well as the clear-cutting and bulldozing of the storage site and construction roads, would be highly visible. The fugitive dust problem would be acute but of short duration (see 3.1 Air Quality). The prominent light-colored scar on the bluff would contrast sharply with the dull gray of the cliff face (see fig. 3.1-4).

At the top of the cliff, 11 storage tanks and support facilities would replace existing vegetation. This would cause a skyline change for foreground viewers. From farther out in the Strait, the subdued color and the shape, form, and texture of the forested cliff would contrast sharply with the tanks and equipment. From local residences and from several points on U.S. Highway 101, the onshore storage facility would be a significant visual intrusion.

Operation Phase

Visual impacts during operation would center around the port facilities.

The size of berthed and queued tankers approaching, leaving, or taking on fuel, would be visually dominant in the harbor.

A major oil spill would severely degrade the scenic quality of the rock riprap, shoreline and water structures of Ediz Hook beaches. The wildlife and fishery resources of the immediate area could sustain extensive damage and visual degradation from an oil spill.

A fire or explosion would cause an immediate significant visual impact of short duration. Burned or damaged structures would represent a significant visual impact until repaired or removed.

Abandonment Phase

Removal of the berthing facilities, pumps, tanks, buildings, and associated facilities would improve the visual quality of Ediz Hook and Green Point.

No impact would result if the submarine pipelines were left in place. The impact of removing the pipeline from the cliff could be more severe than installation. In any case, it would not be possible to restore the original form of the cliff.and the light-colored scar from the cut would be a permanent adverse visual impact.

LAND USE

The narrative and tables that follow identify significant and critical impacts on the land uses described in chapter 2, Land Use section.

Construction Phase

Construction of the port and onshore storage facilities would cause direct impacts as shown in table 3.1-54. Once a land use is displaced, it is unlikely that it will return to its original use. The impacts listed could therefore be expected to continue indefinitely.

Conversion of approximately 110 acres of harbor and tideland log storage lease area to project use represents about 55 percent of the water storage area available to the two companies involved. They report that this area is used to store up to 34 million board feet plus six chip barges. Meetings between the lessees and the Washington Department of Natural Resources (DNR) failed to locate other usable and leasable harbor areas. Crown Zellerbach and ITT Rayonier indicate that their alternative would be to use dry land storage within 10 miles of Port Angeles which might require 60 acres of land. There is vacant land with industrial zoning located near the airport and the Port of Port Angeles 70-acre log storage area. It seems likely that displaced log storage could be accommodated. To do so however, would cause economic, traffic, and air quality impacts.

The off-loading groin used in conjunction with the Ediz Hook erosion control project could also require relocation.

The pilot station, small boat marina, and boat launch could probably be relocated within the harbor. For the pilot station any alternative location, aside from the Coast Guard Station, would increase travel distance for the pilot boats. Relocating these facilities farther west on Ediz Hook would place them behind the remaining log storage areas located offshore and would restrict access.

NTPC has proposed to move their port facility eastward along Ediz Hook to avoid displacing the existing uses described above, and in table 3.1-54. This would eliminate the need to relocate the log storage to a land area, and to relocate the pilot's station, Thunderbird Marina, and the public boat ramp. Nuisance impacts to these uses would remain particularly high during the first 14 months of construction when pilot boats and recreational boaters would have to avoid the adjacent construction area. The vertical omnirange (VOR) station and the offloading groin used for erosion control on Ediz Hook would still probably require relocation. Once in operation the relocated port facility would still be a nuisance factor for pilot boats and recreationists who would have to avoid the trestles, berths, and tankers extending about 775 feet into the harbor adjacent to their facilities. Coast Guard

TABLE 3.1-54 DIRECT IMPACTS--CONSTRUCTION

Project Facility	Area Occupied	Impacted Use and Area	Description of Impact	Degree of Impact
Port berths 1 - 2	45 acres harbor and tideland actually occupied or enclosed 210 acre harbor and tideland lease application; 4.3 acres land area.	Log storage, 110 acres	Displaced to land storage	Significant
		Pilot station, 1 acre	Displaced to other harbor locations	Significant
		Small boat marina 1 acre	Displaced to other harbor locations	Significant
		Small boat ramp, 1 acre	Displaced to other harbor locations	Significant
		VOR (Vertical Omnirange) Air navigation station	Displaced to other location (see section 3.1 Transportation and Utilities)	Significant
Onshore storage	242 acres	One dwelling, otherwise undeveloped private property	Purchase of the property by Northern Tier would have negligible impact in terms of the amount of undeveloped residential property in the area.	Not significant

Ediz Hook marina

BLM

station operations, however, would be more severely impacted if the NTPC port facility were moved eastward. Approximately 40 acres of the 75-acre station would be required for access, and the Coast Guard berth would be displaced. These impacts could require reloction of the Coast Guard Station. The port of Port Angeles has indicated that it would make land near the airport available to the Coast Guard, however, the Coast Guard has expressed no willingness to relocate, and the airport location would be a less desirable location in terms of the Coast Guards' air-sea rescue mission.

All of the above impacts are considered significant because they involve displacing existing uses to their disadvantage.

No significant indirect impacts have been identified. It is unlikely that the construction work force and construction activity would cause existing land uses to change significantly.

Construction would conflict with nearby land uses chiefly through nuisance impacts such as noise, dust, visual disharmony, and increased harbor and street traffic. Construction of the tanker unloading berths and submarine pipeline would affect the U. S. Coast Guard Station, recreational use on Ediz Hook, the log dump operated by Peninsula Plywood, Foss Log Storage, and the Crown Zellerbach pulp mill, at varying intensities through the 18-month construction period.

Construction of the tanker berths would commit approximately 210 acres of harbor and tideland area and 4.3 acres on Ediz Hook to project use for the anticipated 20-year economic life of the project. This might forestall the development of another transshipment facility based on the capability of the harbor to accommodate very large bulk carriers. The likelihood of such a use occurring and its effect, cannot be evaluated with the information presently available.

During construction of the onshore storage facility, the same nuisance impacts would be felt most strongly in the developing residential area to the west and the scattered residences to the east. These nuisance impacts are individually discussed in Air Quality, Soils, Visual, Transportation and Utilities sections. The cumulative effect of these impacts would likely be considered significant.

Initial construction of the onshore storage facility would affect only part of the 242-acre site. Presently, approximately 10 residences are within 2,000 feet of the proposed tank storage site, and 35 residences within 4,000 feet. Additional housing units are being planned for a new subdivision near the proposed storage facility. Construction of the additional storage area, for the ultimate capacity would cause the same nuisance impacts to an unknown number of additional residents.

Construction of the onshore storage facility would commit to project use 242 acres of land zoned for, and adjacent to, residential development. The future use foreclosed would most likely be residential. This represents a negligible amount of the land available in the vicinity for residential use.

Construction of the submarine pipelines to the onshore storage site would involve excavation of a notch in the shoreline cliff at Green Point. This would be inconsistent with Clallam County Shoreline Master Program regulations, which are designed to protect against cave-ins, landslides and erosion, and to preserve aesthetic qualities. The pertinent impacts are described in Topography and Geology, Soils, and Visual sections.

Construction and operation of the tanker unloading facility on Ediz Hook might make it more difficult for the city of Port Angeles to implement a land use recommendation in the comprehensive plan that states: "Public access on Ediz Hook should be retained, and enlarged and improved as recreational areas become available." Section 3.1 Recreation, addresses impacts to recreation use on Ediz Hook.

As indicated in chapter 2.1 Land Use, the proposal would be inconsistent with the present desires of Port Angeles and Clallam County. The proposed onshore storage site would be inconsistent with both planned and zoned land use (agricultural/residential). The proposed use would create an industrial area generally surrounded by low density residential and agricultural land uses. It is likely that the onshore storage facility would remain a single industrial use and that no other industry would develop nearby. Industrial use of the site as planned is not likely to cause significant adverse impacts to adjoining agricultural land uses. However, the residential land use of the area could be adversely affected due to the obtrusive nature of the storage facility.

Log storage area — Ediz Hook

Operation Phase

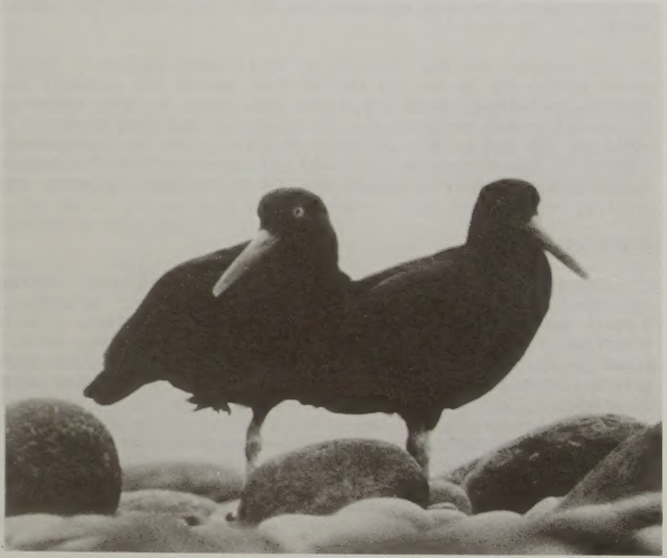
The direct impacts to existing land uses caused by project construction, as shown in table 3.1-54, would continue through the operation and abandonment phases.

It is not anticipated that project operation would cause significant indirect impacts. Land presently devoted to or being developed for residential use should be sufficient for the anticipated population increase. However, any greater than anticipated population increase could be expected to add impetus to the existing trend of converting agricultural land to residential use. Likewise, additional commercial services induced by the project would not occupy significant areas not already devoted to or zoned for commercial use.

Normal operation should not cause significant impacts to wilderness resources except that required air quality incremental standards for the Olympic National Park might not be attained. This would be an adverse impact to wilderness resources in the park.

During operation, the most severe impacts to land use would occur only in the event of an oil spill, explosion, or fire. Tankers entering and transiting the Strait of Juan de Fuca would expose shoreline land uses if large oil spills occurred. Significant areas which might be impacted include the Pacific Rim and proposed West Coast national parks on Vancouver Island; the Makah and Lower Elwha Reservations on the Olympic Peninsula; and urban land uses adjacent to the shoreline. Only very large spills, in excess of 10,000 barrels, would reach shorelines in concentrations sufficient to be a health or safety hazard and to require intensive cleanup efforts. See section 3.1 Oil Spill, Fire, and Explosion Risk Analyses for probability of a spill. Should such a spill occur, oil spill cleanup response would be limited due to the lack of rail facilities west of Port Angeles, and the relatively low standard of State Highway 112.

The land uses most susceptible to impact from an oil spill, fire or explosion, occurring at or near the berthing facility include the industrial harbor uses, the log storage area, and the U.S. Coast Guard Station as well as transportation and recreation uses described in chapter 2, Land Use and Transportation and Utility Networks.



Oystercatchers — Marine shorebirds

Bureau of Land Management

Of the uses considered, the most exposed is the log storage. Unless the oil were concentrated and the exposure prolonged it appears likely that no significant impact would occur. Prolonged exposure to high concentrations might contaminate the exterior logs (about one-third) in each boom. Little penetration would be expected beneath the bark but the oil could penetrate the ends.

Oil soaked logs would present clean-up problems requiring special handling by the pulp and lumber mills. Oil contaminated bark and wood could be used for "hog" fuel, but water effluent from de-barking would require oil separation treatment not presently available. Oil contaminated logs stored for export sale would probably have to be sold locally at a reduced price.

In the event of an oil spill, disposal of oily wastes might adversely affect Port Angeles and surrounding communities. Various local and state ordinances and laws regulate disposition of certain types and amounts of wastes. Oily wastes might be considered hazardous materials, preventing them from being deposited at certain locations or deposited in limited amounts to protect the area's water table from contamination. Disposal of such wastes might create logistical and financial burdens to those communities and agencies involved in clean-up operations.

A worst-case explosion from a tanker at berth could result in scattered damage to structures along the Port Angeles waterfront. Human injuries could occur to a distance of about 1,500 feet which would expose workers in the log storage area, recreationists on Ediz Hook, personnel at the Coast Guard Air Station entrance, and crew members on vessels within the harbor. Moderate structural damage would be anticipated at the main building complex on the Coast Guard Station, and possibly to vessels in the harbor.

At the onshore storage facility a "worst-case" explosion of a storage tank could cause fatalities up to 150 to 200 feet beyond the property boundary to the west. Several residences would be within the range in which human injuries and severe structural damage would occur. An oil spill impacting adjoining land uses would only occur in the event of a multiple failure (tank plus containment dike rupture, or rupture of two or more tanks) could oil spread outside the boundaries of the storage facility or be likely to affect domestic or agricultural water supplies.

Abandonment Phase

The process of abandonment should not cause significant land-use impacts. It is assumed that the facilities would be dismantled and removed. Over an estimated 9-month period this process would cause nuisance impacts similar to those of construction. Increases in noise, dust, visual disharmony, harbor and street traffic would be of lesser magnitude and duration. However, they might be felt just as acutely because more intensive development is anticipated during the intervening 20 years.

Once the tanker berths were removed, the port area should be suitable for other industrial and/or recreational uses. The storage site at Green Point would likewise be suitable for other uses following the removal of its facilities.

TRANSPORTATION AND UTILITY NETWORKS

This section considers impacts that might occur to inland water transport (commercial vessel traffic), roads and highways, railways, airways, and electricity transmission and supply.

Inland Water Transport

Construction Phase

Construction of the port and onshore storage facilities would require an estimated 16 barge deliveries which would have a negligible effect on vessel traffic in the Strait of Juan de Fuca and Puget Sound. Within Port Angeles harbor, periods of inconvenience to other water traffic would probably occur, particularly during the period when the submarine pipelines were being installed. Submarine pipeline construction would require the use of about six large barges, two tugs, and several launches (assuming the bottom pull method were used). The barges would move slowly, more or less in line, across the harbor mouth, and would block only a small portion of it at any one time. If the lay barge method were used, impacts would be greater due to the larger number of barges that would be lined up in the harbor. The construction of the tanker unloading facility would take place during the summer season from four large derrick barges and involve numerous other barges, tugs, and launches. Aside from the inconveniences mentioned above, no other significant impacts to harbor traffic would be likely to occur.

Operation Phase

Once the pipeline system was in operation, tanker traffic to Port Angeles would be about 300 calls per year for the initial throughput of 709,000 barrels per day, and 395 calls per year for 933,000 barrels per day throughput. Bunker fuel would be shipped from California to Port Angeles. As with the construction phase, traffic should not have a significant effect on other traffic in Puget Sound or the Strait. Initially, commercial vessel traffic in the straits would be increased by about 8 percent over 1977 levels and by 10 percent at maximum throughput. At Port Angeles harbor, tankers would be arriving randomly at a rate of zero to three per day. An unknown number of tankers or barges would additionally be required to supply bunker fuels. Tugs and towboats would also be needed. For the initial throughput, commercial vessel traffic at Port Angeles would increase by about 34 percent over 1977 traffic, as shown in tables 2.1-21 and 2.1-22. If tanker calls were to increase to 395 per year, this percentage would rise to about 44 percent. Considering large vessels (freighters and tankers) only, NTPC tanker traffic would bring increases of 145 percent initially, and 188 percent ultimately. Random tanker arrivals would result in queuing. Average waiting times could be about 5 hours initially, lengthening to 10 hours if tanker calls were to increase to 395 per year. These traffic levels, combined with the harbor encroachment of the berthing facility and possible restricted anchorage area over the submarine pipelines, would cause an overload of vessels desiring anchorage in the inner harbor. This is considered a significant impact since some vessels might have to anchor outside the harbor, or during inclement weather, to anchor at another harbor or bay.

Oil spills of 2,000 barrels or more within the harbor, or a catastrophic spill of 10,000 barrels or more in the Strait of Juan de Fuca, might significantly disrupt commercial vessel traffic, as ships would attempt to avoid areas with a heavy oil

Coast Guard Station on Ediz Hook BLM

Port Angeles marina BLM

slick or where cleanup operations were concentrated. The duration of this impact would probably range from a few days to a week depending on the size and location of the spill, weather conditions and the effectiveness of cleanup efforts. See section 3.1 Oil Spill, Fire and Explosion Risk Analysis for estimated probability of occurrence.

An at-berth fire or explosion could significantly impact other commercial traffic in Port Angeles harbor. A large fire might disrupt such traffic while an explosion could cause physical damage particularly to vessels entering or leaving the harbor. Traffic data for 1977 indicates that daily arrivals and departures average 20 vessels per day.

Abandonment Phase

Dismantling the port and onshore storage facilities could hamper other Port Angeles harbor traffic. The inconvenience would be of a lesser magnitude and duration than that caused by construction since the removal time would be shorter and the submarine pipeline would probably remain in place.

Road and Highway Networks

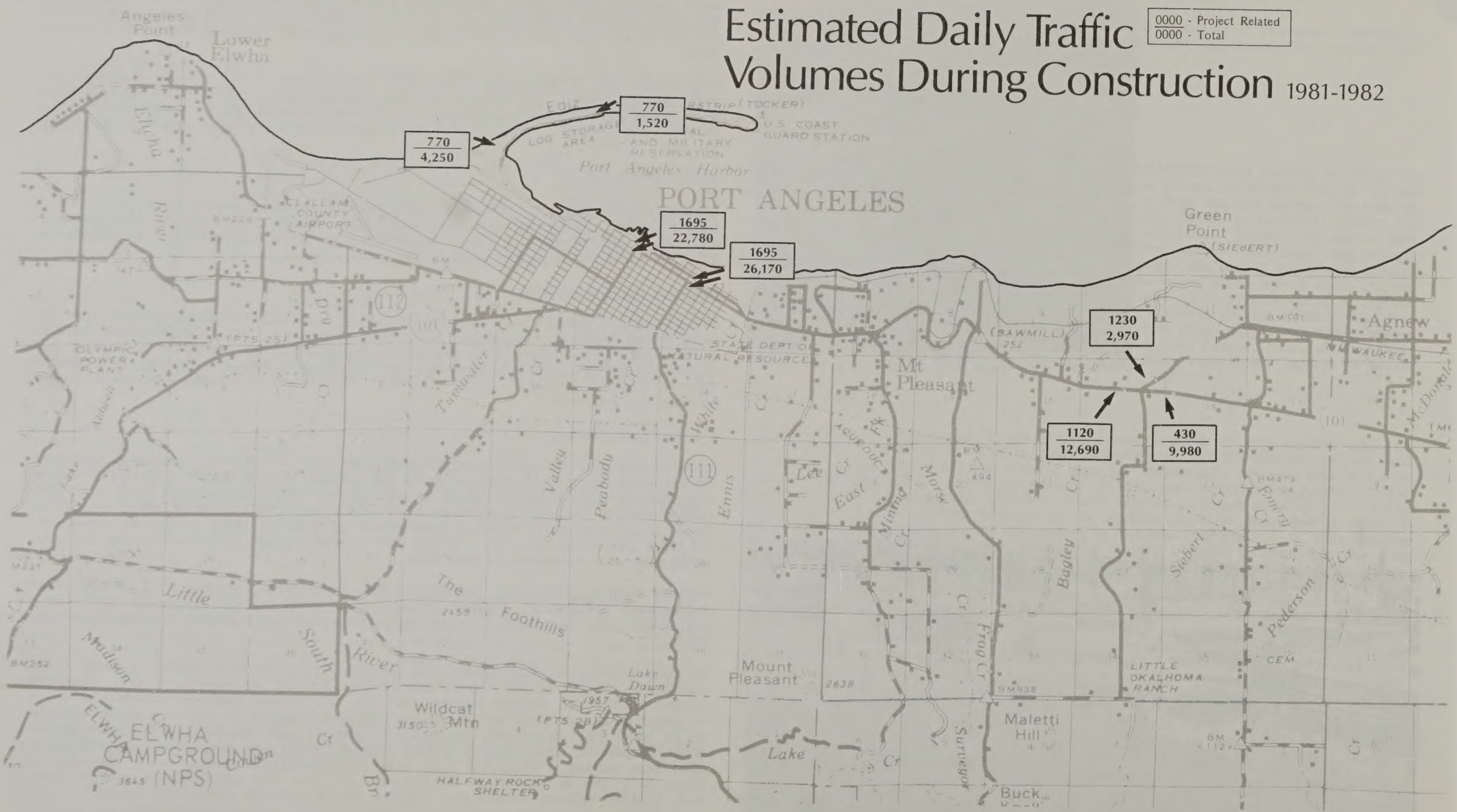
The discussion that follows is keyed to figure 3.1-5 which displays the locations of anticipated impacts, and table 3.1-55 which describes them. Estimates of traffic volumes and their impacts were derived by projecting rates described in section 2.1 Transportation and Utility Networks, to 1980-81, and adding estimates of project-related traffic provided by NTPC (1978). Work force estimates are described in section 3.2 Economics.

Construction Phase

Construction activity would generate additional road and highway traffic, principally to the port facility on Ediz Hook and the onshore storage facility at Green Point. The maximum labor force traveling to and from to Ediz Hook would peak at about 365 people during the second quarter of construction (January-March 1981). Project material and equipment would be transported by road and would involve an average of 21 truck deliveries per day. It can also be anticipated that construction activity would draw some onlookers to Ediz Hook.

Besides delays, additional traffic on Ediz Hook might increase the need for road maintenance and repair. Construction activity and traffic congestion might delay U.S. Coast Guard personnel in returning to the Coast Guard station for emergency duty calls.

In the vicinity of Green Point the largest project-related traffic volumes would probably occur during the second construction quarter (January-March 1981) when the submarine pipeline, onshore storage facility, and initial pipeline construction would be concurrent. As many as 550 workers would be required in the area and an average of 65 truck deliveries per day would be needed. Of the traffic to Green Point, about 75 percent would come from Port Angeles, while the remaining 25 percent would come from Sequim. Following this peak project-related traffic would decrease to about half the volume shown on figure 3.1-5 for the remainder of construction. Peak traffic volumes within Port Angeles would coincide with those occurring near Green Point. After the second construction quarter (January-March 1981) the traffic volumes would decrease to 50 to 60 percent of the levels shown on figure 3.1-5 and



Estimated Daily Traffic Volumes During Construction 1981-1982

Figure 3.1-5

Sources: Traffic Projections (NTPC-1978) Construction Truck Traffic (Butler Associates as cited by NTPC-1978) Construction Worker Traffic (Developed by BLM E.S. Team-1978)

Table 3.-55

STREET AND HIGHWAY IMPACTS, PORT ANGELES AREA

Potential Impact Locations	Estimated 1980 Traffic Volumes and Service Levels3/ (Without Project)		Estimate of Project Induced2/ Traffic Increase		Impact Description	Degree of Impact
	ADT	p.m. Hourly Peak 1/	ADT	p.m. Hourly Peak		
Marine Drive (south of Crown Zellerbach plant)	4,030 4,030	485/A 485/A	770 770	365 365	The worst congestion might occur near the Crown Zellerbach plant where traffic is constricted.	Significant
Marine Drive on Ediz Hook	1,300	155/A	770	365	Traffic increase would be noticeable but no decrease in level of service is likely to occur.	Not significant
Old Olympic Highway	1,920	230/A	1,230	560		
U. S. 101 (East from junction with Old Olympic Highway)	9,640	1,155	430	195	Traffic increase would be noticeable but no decrease in level of service is likely to occur.	Not significant
U. S. 101 (West from junction with Old Olympic Highway to Bagley Creek Road)	11,820	1,420	1,120	510	Traffic increase would be noticeable but no decrease in level of service is likely to occur	Not significant
Port Angeles central business district	21,760	2,610	1,695	785/D	Construction traffic might lower peak hour service levels during the 31-month (Jan. - March 1981) peak, and again during the following summer tourist season.	
	Existing service level is generally C.					Significant

1/Assumes a 12 percent peak hour factor.

2/Assumes one vehicle per commuting worker and truck deliveries averaged over 8 hours.

3/ See table 2.1-24, service levels, for explanation of rating.

ADT = average daily traffic

Marine drive on Ediz Hook Bureau of Land Management

on table 3.1-55 for the remainder of construction. As indicated in section 3.1 Land Use, displacement of log storage in the port to a site on land would probably increase truck traffic within the city while decreasing the number of rafted logs and chip barges entering the harbor. Most of this truck traffic would enter Port Angeles from the west and travel to the Crown Zellerbach plant along Truck Road and Marine Drive. There is not enough information available at this time to estimate the volume of this increased wood products truck traffic.

Additional traffic should not significantly alter the impacts or estimated traffic volumes reflected in table 3.1-55.

Operation Phase

During operation, induced traffic at the locations shown in table 3.1-55 would be considerably reduced. At the port facility there would be 15 to 20 employees with 9 to 12 normally working a day shift. Tanker arrivals and departures would add a maximum of 30 round trips daily along Marine Drive. This would be a noticeable increase in traffic, but should not lower service levels.

At the onshore storage facility there would be 28 to 33 employees and truck deliveries would be minimal. No significant impact would occur.

For downtown Port Angeles the anticipated project induced population increase of less than 1 percent would result in a minimal increase in traffic.

Abandonment Phase

Removal of the project facilities would cause temporary traffic level increases similar in magnitude to those caused by construction, but of shorter duration.

Railroads

Construction Phase

Construction of the port and onshore storage facilities would involve shipment of some materials by rail. An average of three car loads per day during the first quarter has been estimated with shipments decreasing thereafter (NTPC 1978). There would be ample capacity on the Seattle-Port Angeles line to handle this anticipated traffic, assuming that existing rail facilities remained intact and that arrangements could be made for their use.

The flow of construction traffic across the railroad right-of-way should not have a significant impact on rail traffic.

Operation and Abandonment Phases

Operation and abandonment of the port and onshore storage facilities should not significantly affect any railroad network.

Air Transport

Construction Phase

Construction of the port facility would require relocation of the Ediz Hook Vertical Omnirange (VOR) station. The VOR is an air navigation aid, for which the siting criteria require that there be no structures or obstructions within 750 feet. A new location for the VOR might be found at the William R. Fairchild International Airport. Assuming that the station could be moved to a satisfactory site without a break in service, a significant impact to air traffic might not occur. However, in view of the engineering studies, air navigation chart revisions, and expense involved in moving a VOR, its relocation is considered a significant impact.

The Coast Guard's air operation at Ediz Hook might be adversely affected by both construction and operation of the port facility. Although not in the direct flight path for the runways, the height of the tankers (up to 175 feet) and the 80-foot access towers and marine arms might be construed as hazards because of their location (approximately 600 feet offset from the extended runway centerline, and 600 feet from the threshold).

Operation and Abandonment Phases

Artificial lighting associated with the proposed port could impair the night vision of Coast Guard air crews, creating a safety hazard at the Ediz Hook air station. The terminal facilities could also restrict the use of the air station by the Boeing Commercial Airplane Company and Pearson Aircraft Inc. Both companies have Coast Guard permits to land at the air station on occasions when inclement weather forces the closing of William R. Fairchild International Airport.

Project induced air traffic should not significantly affect operations at Fairchild International Airport.

Electric Transmission

Construction Phase

Construction of the port and onshore storage facility would require additional electric transmission facilities (table 3.1-56), as well as substations located at the respective facilities. Increased electric loads required for construction of the facilities would not be significant for either of the utilities.

TABLE 3.1-56 NEW ELECTRIC TRANSMISSION FACILITIES REQUIRED

Serving Utility	Facilities	New Right-of-Way Required
City of Port Angeles	2.5 miles, 69-kV transmission line to be built on existing line or buried within existing right-of-way	None
Clallam County	1 mile, 69-kV transmission line	1 mile 75 feet wide (9 acres)

Operation Phase

Once in operation, the port and onshore storage facilities (combined with pump station 1) would make significant power demands on the two utility systems (table 3.1-57). Both utilities have indicated that they cannot guarantee a firm energy supply for NTPC.

BPA's legal obligation to serve the utilities firm energy requirements ends, and an allocation system begins, on July 1, 1983. Port Angeles City Light and Clallam County Public Utility District existing contracts with BPA expire at the end of 1984 and 1985 respectively. BPA is currently developing a new allocation formula to be used in future sales contracts.

If current forcasts hold, and using BPA's existing allocation formula, Port Angeles City Light would have a firm energy supply in 1986 of approximately 91.6 megawatts which includes 5.4 megawatts contracted from Washington Public Power Supply System (WPPSS) nuclear units 4 and 5. With a firm energy supply of 91.6 megawatts and an expected load of 110.5 megawatts, it can be seen that Port Angeles City Light will experience a 18.9 megawatt deficit of firm energy in 1986. Adding NTPC's initial 3.8 megawatt load leads to a forcasted deficit of 22.7 megawatts, which would increase to 23.8 megawatts if NTPC increased its throughput to 933,000 barrels per day.

Clallam County Public Utility District has an expected firm energy supply in 1986 of approximately 89.9 megawatts, which includes 34.2 megawatts contracted from WPPSS. With an expected average load of 77.1 megawatts in 1986, Clallam County Public Utility District would be approximately 12.8 megawatts in excess of its firm energy needs.

Even adding NTPC maximum 12.6 megawatts load, the utility district should have enough firm energy to handle anticipated demand.

If the utilities contract with NTPC to supply firm energy and critical hydro conditions occur, the utilities would not be able to meet their contractual obligations and would be forced to curtail service to industrial customers. This would result in worker layoffs and lost revenues for the industries affected. Under the State of Washington Emergency Power Act, energy supply facilities would be given high priority

TABLE 3.1-57 ELECTRICAL ENERGY SUPPLY IMPACTS

	1981 (calendar year)						1986 (calendar year)					
	Average Loads (megawatts)			Peak Loads (megawatts)			Average Loads (megawatts)			Peak Loads (megawatts)		
Serving Utility	Current Forecast	Northern Tier	Percent Increase	Current Forecast	Northern Tier	Percent Increase	Current Forecast	Northern Tier	Percent Increase	Current Forecast	Northern Tier	Percent Increase
Port Angeles City Light Department	103.4	3.8	3.7	155.9	15.6	10	110.5	4.9	4.4	172.5	15.6	9.0
Clallam County Public Utility District 1	58.0	6.3	10.9	132.5	6.6	5.0	77.1	12.6	16.3	165.8	13.3	8.0

Sources: BPA 1978; NTPC 1978

Street scene in Port Angeles

BLM

in times of a power shortage. Such priority consideration would cause interruption and curtailment of service to other utility customers, including residential users. If during a critical water short year power were temporarily interrupted, tankers could be forced to queue in the harbor, compounding the effects on marine traffic described previously.

The magnitude of the impact would depend on the severity and duration of the power shortage. The risk of these occurrences represents a potentially significant impact. In addition, the NTPC load would further limit local utilities' already limited ability to serve additional demands.

Abandonment Phase

Abandonment of the project should not cause any significant impacts to electrical supplies or transmission networks.

RECREATION

Project related impacts to recreationists varies from inconvenience to long-term losses of certain activities. Table 3.1-58 summarizes the anticipated impacts to recreational activities.

In general, recreationists would be impacted in the following ways:

1 - general disruption and disturbance of recreational activities;
2 - loss of opportunity to pursue some recreational activities;
3 - competition for access to harbor related recreation;
4 - general degradation of the aesthetic and recreational environment.

In the following discussion, marine-related recreation is considered to consist of pleasure boating (sail and motorized), fishing, shoreline activities (such as shellfish collecting, use of beaches, and scuba diving), nature viewing, and photography. Non-marine recreation includes the use of urban parks in the Port Angeles vicinity, Olympic National Park, and area tourism.

Marine-Related Recreation

Construction Phase

As addressed in section 2.1 Recreation, the current (1978) availability of launching and docking facilities for recreational boats is considered insufficient to meet demand. Although NTPC has proposed to reestablish the public dock and Thunderbird Boat Marina displaced by the proposed port, NTPC has not designated when or where this would be done. According to the Thunderbird Boat Marina (pers. comm. 1979), there are no other available locations along Ediz Hook which could appropriately accommodate the marina. The loss of these facilities for one or more use seasons would be considered a severe impact by area recreationists. Alternative vacant boat moorage facilties are not available.

Construction activities and noise in the harbor during winter months could cause fish to temporarily relocate. Winter sport fishing in the harbor probably would be lost for the season. In addition, summer recreational fishing and shellfish collection between Port Angeles and Green Point would be reduced as a result of suspended sediment in the water, decreased availability of moorage and launching facilities in the harbor, general harbor congestion and noise during construction, and by the submarine pipe laying operation. (See 3.1 Marine section for discussion of impacts on fish and shellfish.)

Casual recreational uses of Ediz Hook for bird watching or enjoying the views of the Strait and islands would decrease for the duration of the construction phase. For some, these activities would be considered a permanent loss as a result of traffic congestion, increased noise, and general industrial character of that portion of the Hook.

Operation Phase

Congestion in the harbor or in the the turning lanes would create a potentially dangerous situation for recreational boats. The Coast Guard may require vessels to maintain a 1,500- to 4,000-foot separation distance from the tankers and also forbid anchorage along the submarine pipeline (U.S. Coast Guard, pers. comm. 1979). This would affect such recreational uses as pleasure boating and sport fishing.

Tanker and vehicle traffic at the proposed port may limit both car and boat access for anglers during the salmon derbies held each summer. During previous derbies, approximately 2,000 cars and boat trailers have parked along the Hook. The presence of large tankers in the harbor could restrict or endanger movements of the numerous derby-related recreatioal craft.

Scuba diving off the end of Ediz Hook might not be permitted.

In general, the Hook would become a less desirable place for all recreational activities.

Abandonment Phase

Removal of the berthing facilities would cause inconvenience, noise, and other impacts similar to those during construction. If the berthing facilities were not removed, it is unlikely that the Hook would be considered attractive for most recreational uses.

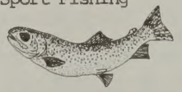
Non-Marine Recreation and Tourism

Construction Phase

The major impact to urban forms of recreation would be inconvenience and some crowding in the use of city and county park facilities.

The disrupted character of Ediz Hook and increased industrial truck traffic along Highway 101 and in Port Angeles would detract from tourist's visitation.

TABLE 3.1-58 SUMMARY OF ANTICIPATED IMPACTS TO RECREATIONISTS

	IMPACT INTENSITY AND DURATION			
ACTIVITY	CONSTRUCTION	OPERATION	ABANDONMENT	REMARKS
Boating	Low to Severe	Moderate to severe	Low	Nuisance impacts to recreationists in Ediz Hook vicinity; harbor congestion may be a severe impact if the Thunderbird Boat Marina and public boat launch are not relocated prior to construction activities. Increased potential for tanker-recreational boat accidents. Severe impact if tanker explosion or submarine pipeline leak; physical and oil damage to boats.
	← Short to long term →			
Sport Fishing 	Low to Moderate	Moderate	Low to Moderate	Impacts primarily low and nuisance related to harbor congestion, and temporary relocation of fish in harbor; may be moderate during salmon derbies if written agreements are not enforced or if there is no room for parking (up to 2000 cars) along the Hook. Oil spill would contaminate fish and indirectly affect anglers for the duration of the cleanup.
	← Short Term →			
Miscellaneous Marine related (shoreline parks, beaches, wildlife viewing, shellfish collecting etc.)	Low to Moderate	High	Low to Moderate	Some resources (e.g. Shellfish beds) would be lost during construction and abandonment and several years afterwards. An oil spill or submarine pipeline leak could affect resources and recreationists for one or more seasons. This might be severe if the area is repeatedly affected by chronic low level spills or if the area previously impacted is re-impacted before reaching equilibrium.
	← Short Term →	← Short to Long Term →		
Tourism	Moderate to High	Low to Moderate	Low	Inconveniences related to construction and abandonment activities and noise. If a major spill occurred, it could affect a portion of use season. Interruption of ferry service or a significant change in the ferry turn around time could affect the Black Ball ferry business and Port Angeles as the point of departure for Victoria, B.C.
	← Short Term →			
National and urban parks	Low	Low	Low	Potential crowded conditions of county and municipal parks during peak tourist season by construction and abandonment crews and their families. Plume over Port Angeles would detract from views of Strait observed within the Olympic National Park.
	← Short Term →			
Pacific coast wilderness beaches and trails	None	None	None	Oil spills could affect Pacific coastline from Grays Harbor to Cape Flattery High Scenic Values.
	← Short Term →			

Short term Impact - an impact which occurs during the construction or abandonment phases and/or one to two growing seasons thereafter. A short term impact may also occur as a result of activities associated with the operation phase of the project.
Long term Impact - an impact which continues for an extended period of years; may be permanent.
High Impact - an impact that will affect the majority of recreationists for one or more recreational seasons, or, an impact that has permantly changed the availability of the resource to recreationists.
Moderate Impact - an impact that will affect noticeable numbers of recreationists by eliminating the opportunity for recreational activities for the major portion of a use season.
Low Impact - an impact that will affect few recreationists due to the widespread availability of the resource opportunity, or, due to the short term effect of the impact.

Operation Phase

Changes in air quality during normal operating conditions would have little effect on recreationists.

Abandonment Phase

Removal of the port and onshore storage facilities and the submarine pipeline to Green Point would not significantly affect recreationists. Congestion of city parks and use of motels would probably occur.

Oil-Spill Impacts

In addition to the proposed port facility at Port Angeles, the submarine pipeline, and onshore storage facility at Green Point, the following discussion considers areas along the Pacific coast, Strait, or Sound, which may be impacted by an oil spill at sea.

Immediate impacts to recreationists from an oil spill at sea include oil fouling of recreational boats and gear, loss of sport fishing opportunity, contamination and loss of shellfish beds, oil fouling of beaches, loss of migratory and resident bird populations, and the general unsuitability of the area to support recreational pursuits. Most of the above impacts are short term (duration of cleanup). The size of spill and time of year is an important consideration for determination of the magnitude of the impacts to recreationists. See section 3.1 for discussion of oil spill risk and impacts to marine mammals.

Opportunities for sport fishing would be temporarily lost as a result of an oil spill. Containment efforts might prevent or restrict access to other fishable areas.

Recreational shell fish collection would not be possible for at least 4 years, with 5 to 10 years more probable. Recreational use would probably shift to another area and would increase recreational pressure there.

Public beaches are limited and receive capacity use during the summer. Removal of oiled sand from an oil spill would only partially clean the area. Desirability of the beach would decrease for one or more seasons.

Tourism could be impacted by a large spill. The Puget Sound and Strait of Juan de Fuca would be less desirable for recreationists. Containment and cleanup efforts would detract from use of shoreline areas.

The major impact from an explosion in the harbor would be damage to recreational boats and possible bodily harm to recreationists in the area. A submarine pipeline leak would foul boats and affect sport fisheries for the duration of the leak and cleanup. Offshore and tideland shellfish beds would become contaminated and limit recreational use of that resource for several years.

ECONOMIC CONDITIONS

Fisheries

Construction Phase

The total sport and commercial value of geoduck and clam resources in the Port Angeles-Green Point area is more than $500,000 per year or more than one-half the $1 million combined total value for the Strait of Juan de Fuca. Approximately one-half of the clams and geoducks in the Port Angeles-Green Point area would be destroyed during construction, resulting in a loss of $250,000 per year. Lost geoduck values would persist 3 to 10 years and lost clam values for 2 to 5 years. Other fisheries resources which would suffer losses include oysters, crabs, bottomfish, and herring.

Operation Phase

Losses to fisheries resources would result from chronic low-level oil pollution during operation for the life of the project. Economic losses would be moderate primarily resulting from diminished geoduck and clam harvests in the Port Angeles-Green Point area. Lesser economic losses would occur as a result of diminished shrimp, crab, oyster, bottomfish, salmon, and herring resources in the same area.

Economic losses from an oil spill would be proportioned to the severity of resource damage, which would depend on location and size of the oil spill, season, species present, and success of containment and clean-up. Quantification of economic losses has not been made.

An oil spill would cause substantial destruction of geoduck, clams, oysters, shrimp, and crabs over a period of several years. Losses could also effect the herring and smelt fisheries, depending on the season. The value of the bottomfish harvest could be reduced if the fish became tainted. Halibut spawning areas in Port Angeles and Dungeness could also be impacted.

Boat and gear cleanup costs and loss of fishing time would be experienced by anglers. Claims for direct economic losses could be made against the parties responsible for an oil spill. Other losses would be borne by commercial and sports anglers, fish processors, sporting goods stores, and marinas.

Abandonment Phase

There would be no significant economic impacts during the abandonment phase.

Population

Construction Phase

Population gains that would result from construction are shown in table 3.1-59. The population of Clallam County would be temporarily increased by advance construction personnel and job seekers beginning several weeks prior to construction. The number of job seekers is unknown.

TABLE 3.1-59 CONSTRUCTION IMPACTS ON POPULATION AND EMPLOYMENT, CLALLAM COUNTY 1/
(Average number except as noted, initial construction phase)

Impact	Dec. 79- Mar. 80	Apr. 80- Jul. 80	Aug. 80- Nov. 80	Dec. 80- Mar. 81	Apr. 81- Jul. 81	Aug. 81- End
Transient Population: 2/						
Maximum	1,507	818	771	675	722	69
Average	1,173	715	760	673	459	26
Construction Workers:						
Total (local & non-local)	539	320	348	310	206	24
Local only	62	45	50	46	29	2
Total Employment: 3/						
Total (local & non-local)	730	516	523	467	330	25
Local only	215	203	189	171	128	13

1/ Estimation methods are described in Pipeline System-Economic Methodology.

2/ Transient population represents the number of workers and families of workers in construction and in other industries stimulated by construction who would be temporarily lodged in the county during construction. It does not include unemployed job seekers.

3/ Total employment includes the construction work force lodged in the county and employment generated in other local industries by construction activity.

During the first 4 months of the 22-month construction and testing period the population would increase by about 900 to 1,500 persons (2.0 to 3.4 percent of the projected 1980 population), including the families of construction workers and non-local workers in other local industries stimulated by construction. By early summer 1981 the transient population would decline and remain at about 700 to 800 until early summer 1982 at which time it would decline to less than 100.

At the peak of activity, workers commuting from other counties would increase the daytime population by about 100. The peak population increase including commuters would amount to about 3.7 percent. Added to the projected 2.1 percent rate of population increase for 1980 without the project, the total percentage increase would be less than the 9 percent experienced between 1976 and 1977, but higher than the average of 3.6 percent projected between 1975 and 1980. The impact would be significant. The current influx of older persons to Clallam County (over one-half the 1976-77 increase) could be temporarily diminished by construction of the port. At the same time young people who would have left to seek work elsewhere might decide to stay. During construction to increase to 933,000 barrels per day throughput, the ultimate construction phase, the transient population probably would not exceed 500 which is not considered a significant impact.

The assumptions on which population, income, and employment estimates for construction are based are discussed under "General Economic Methodology," in the pipeline section.

Operation Phase

The resident population would be increased by about 380 persons during operation. Families of NTPC personnel would comprise about 70 percent of the increase. The increase would be less than 1 percent of the population in the initial year. The impact would not be significant.

Abandonment Phase

Abandonment of the pipeline would result in a loss of about 380 residents. If the facilities were removed, the transient population associated with the removal would probably be fewer than 100 persons, who would probably enter after operating personnel had left the area. These impacts would not be significant.

Industry and Employment

Construction Phase

Total employment of workers residing in Clallam County would average about 470 over the 22-month period of the initial construction phase with a one-month peak of about 970. About 60 local workers would be employed at peak times on the construction work force and about 150 in jobs generated from expenditures by construction workers and local construction procurement. Employment of local workers during the initial construction phase would total about 310 man-years. Local employment estimates are based on the assumption that union job placements would come equally from union's jurisdictional areas. Higher levels of local employment might result from an NTPC program to employ local workers. Unemployment rates would probably be increased temporarily by an influx of job seekers, but it is unlikely that many job seekers would stay without employment. The temporary gain in local employment would be significant.

Local governments and community services might experience minor and temporary deteriorations if some personnel move to higher-paying construction jobs. Higher hourly union wage scales for most skilled jobs associated with construction would place upward pressure on non-union wages, especially in the less skilled services sector. Improved wages and additional job opportunities produced by construction activities would be viewed as beneficial by local workers. Local shops, motels, and other service-oriented businesses dependent upon unskilled labor would experience higher operating costs, but these should be offset by increased business activity. Higher wage levels produced by construction activity probably would not be sustained after the construction period.

Construction of the port would cause the loss of a portion of the harbor log storage area which is discussed under Operation Phase below. Relocation of the pilot station, two boat launches, and the small-boat marina would be required. Relocation costs would be borne by NTPC.

Tourism would be adversely affected by crowded conditions and lack of accommodations. Transient lodging which is normally near capacity during the summer would be partially occupied by workers. Reduced availability of facilities would affect recreational fishing, ferry traffic, and visits to Olympic National Park. The reduction in tourism would be more than offset by increased business from construction-related activities for most businesses. However, the ferries, marinas, and other businesses dependent on recreational fishing and businesses dependent on tourist trade at places remote from construction activity would be adversely impacted. The magnitude of these impacts has not been determined. Employment during ultimate throughput construction phase would probably average about 200 workers over the 9-month construction period, or fewer if the construction period were longer. This impact is not considered significant.

Operation Phase

Sixty-three personnel would be employed in Clallam County for operation of the NTPC system.

NTPC (1978) estimated that 18 percent (41 crewmen) from NTPC tankers would reside in Washington, and that one-third of those (14 crewmen) would locate in Clallam County.

Additional local employment would be generated from expenditures by personnel and other expenditures associated with port and pipeline operation. Each ship in the Alaska trade would require about $151,000 (1978 price level) in food and stores each year or about $4,500 per visit. Foreign tankers would be at sea nearly eight times as long on each voyage assuming 9,000 miles compared to 1,169 miles one way, but would make only half their purchases in a U.S. port. Estimated expenditures per visit would be about $18,000 for 80 visits per year. Combined ship store purchases would amount to about $2.4 million per year during the initial phase. Crews visiting shore might spend $200,000 per year assuming 300 tanker visits, 27 crew members, and an average expenditure of $25.00 per visit.

Local procurement expenditures for operations and maintenance would be minor. These expenditures together would generate about 28 additional local jobs. Employment generated by bunkering and tug operations would probably occur outside the county. These impacts are not considered significant.

Additional Petroleum-Based Industry. The development of refining or petrochemical operations in the Port Angeles area is considered unlikely. Air pollution standards and community opposition appear to be insurmountable obstacles even though such a location might be less expensive than other locations in some circumstances. Location factors, potential markets and market interest, and location prospects are discussed below.

Location Factors. In the absence of other factors refinery location is determined by the location of crude oil supplies and product markets. There are savings in fuel costs for a refinery located near a crude supply. However, location near product markets is most economical because of higher cost of transporting products.

Other factors affecting refinery location include resource requirements, environmental constraints, and local public opinion. For example, a 200,000 barrel per day refinery would require from 500 to 1,700 acres of industrial land, depending on method of delivery, refinery complexity, and environmental considerations. It would require from 5.8 to 37.4 million gallons of water per day depending on whether it was air-cooled or water-cooled. Electric power requirements would range from 0.5 to 1.3 million kwh per day. Petroleum refining and petrochemical production produce sulphur oxides, nitrogen oxides, particulate matter, and other air pollutants which cannot presently be eliminated. Refineries are not public utilities. They must be acceptable to the local community and cannot be imposed on the basis of a larger public interest (Corps of Engineers Deepwater Port Study 1973).

Petrochemical plants, separate from refineries, have similar characteristics but much larger labor force requirements. The type of petrochemical facility which might be built in Washington would be a 40,000 barrel per day plant employing 1,100 workers as compared with about 300 workers for a 200,000 barrel per day refinery (Stokes 1974). Petrochemical plants tend to locate near refineries for their feedstocks but not necessarily near a port. Their need is for rail and highway access, a labor pool, and associated community facility requirements (LOOP FES 1976).

Potential Markets and Market Interest. There are two markets which a Puget Sound refinery or petrochemical plant might serve; the Washington-Oregon coastal region,and California or Japanese markets. Puget Sound production for inland areas would be uneconomical because of high transportation costs. Any need for increased regional refinery production would be met by refinery modifications occasioned by the changing composition of available crudes (Stokes, telephone interview 1979). However, some new refinery construction might take place.

Demand in California for Puget Sound production is a result of the limitation of California production as a result of air pollution problems. These limitations apply primarily to the Los Angeles area. Refinery sites are available in the San Francisco area (Corps of Engineers 1973). The ARCO refinery of Puget Sound presently markets part of its production in California. Standard Oil of California, however, has not utilized a Puget Sound refinery site which it owns (Stokes 1979).

The existence of a Japanese market for petrochemicals is presumed from industry proposals to supply such a market. No information pertaining directly to that market was obtained.

A Puget Sound petrochemical plant was proposed in 1973 as a result of California and Japanese interest in supplies. California utilities were seeking to augment naptha which had been restricted in California as a result of environmental problems (McPhee telephone interview 1978).

Interest in refinery or petrochemical production at an oil port has been stimulated by the prospective Alpetco refinery at Valdez. Location at Valdez is based principally upon the availability of crude oil under a long-term supply contract for Alaska state royalty oil (Alpetco telephone interview 1979). Refinery production of 150,000 barrels per day would consist of 100,000 barrels per day of unleaded gasoline, 30,000 barrels per day of jet fuel, and 5,000 barrels per day of diesel, all for West Coast markets; and unspecified amounts of naptha, benzene, and toluene for west coast and Japanese markets. Operation would begin in 1984 (Alpetco telephone interview 1979).

A proposal for a large Puget Sound refinery combined with electric power production was announced by Alaska Petrofining in January 1979 (Seattle Post-Intelligencer 1979). Port Angeles was cited as a potential location. The basis for the proposal is unknown.

Location Prospects. Location of a refinery in the Port Angeles area to serve the Washington-Oregon market would be substantially more costly than a location near existing refineries because of high transportation costs for refined products. A plant serving California or Japanese markets is assumed to have equal transportation costs and possibly lower crude supply costs than east Puget Sound refineries. Crude supply costs to existing Puget Sound refineries could be increased by about 18 cents per barrel (pipeline tariff estimate from DOE 1979) minus existing cost (Texaco

1977) if direct tanker deliveries were prohibited. This cost differential would provide considerable financial incentive for locating in the Port Angeles area.

However, location of refineries or petrochemical plants in the Port Angeles area would not be likely because of air quality regulations. Olympic National Park headquarters is a Class I area, which severely restricts allowable incremental increases in sulfur dioxide and particulates. If the proposed project were implemented, a large portion of the allowable increment could be used up. As a result, few new sulfur dioxide sources could be allowed. Refineries release even larger quantities of sulfur dioxide, so there would be little chance that these would be feasible. Other factors might inhibit or prevent plant location, including the availability of land and power. It is also presumed, on the basis of opposition to the proposed port, that the community would exercise its option to reject any additional petroleum industry.

Two local petroleum industry experts said refinery or petrochemical operations in the Port Angeles area were unlikely (Stokes 1979; Betts 1979). It was therefore concluded that such industry would not develop if the NTPC proposal were implemented.

Other Industry and Employment Impacts. Oil spills in the marine environment would affect commercial and recreational fishing as discussed above. Damages to aesthetic and recreational values from oil spills would have a minor effect on tourism. For example in Santa Barbara, motel business was down about 10 percent during the summer of 1969 following the massive oil spill there (NASH 1972). Tourist-related business in Port Angeles has a greater dependence upon visitation to Olympic National Park and ferry passages than on waterfront recreation and fishing. Effects of an oil spill on motel trade would be relatively insignificant. A spill which landed on Dungeness beaches could reduce visits to that area for a season, but would not significantly affect tourism in Clallam County.

The cost of cleanup would be related to spill location and size, weather, wind, currents, surface conditions, season of the year, number and sensitivity of affected shorelines, and the speed of delivery, adequacy and effectiveness of cleanup equipment and personnel.

While the cost of cleanup of a potential oil spill cannot be determined, some cost estimates are available for particular cleanup activities of past oil spills. Fisheries and Environment of Canada (1977), estimated the following cost of cleanup per lineal foot of shoreline: $9.60 for mud flats; $8.40 for cobbles and rocks; $6.00 for cliffs; and $4.80 for sand beaches.

Offshore cleanup costs can not be directly estimated, but would be related to the speed of cleanup, equipment operating cost, travel distance, and debris disposal costs.

An example of cleanup costs of a major tanker spill is from the Torrey Canyon spill. The Torrey Canyon was carrying 119,000 tons of crude oil (about 775,000 barrels) when it ran aground and brokeup near Lands End, England, in 1967. Quantifiable cleanup costs have been calculated at approximately $27.5 million, which exceeds the value of about $23.4 million for the ship, its cargo, and attempted salvage operations (Burrows et al. 1974).

The Water Quality Improvement Act of 1970 (P.L. 91-224) makes a vessel owner or operator responsible for paying spill cleanup to the amount of $14 million or $100 per gross ton, whichever is the lesser.

The Trans-Alaska Pipeline Authorization Act of 1973, established a $100 million Trans-Alaska Pipeline Liability Fund to pay for damages and cleanup costs as a result of a vessel oil spill. The fund is maintained by a levy of 5 cents per barrel of oil loaded on vessels. Based on present and projected ANS production, the Liability Fund has an estimated build up of $15 million and would reach the $100 million level in 4 more years, barring no major drawdowns.

There are also two compensation arrangements created by the oil industry (Burrows et al. 1974). The Tanker Owners Voluntary Agreement Concerning Liability for Oil Pollution (TOVALOP) included more than 95 percent of world tanker tonnage in 1971. TOVALOP presently provides a maximum of $10 million for each TOVALOP tanker in any one incident. Compensation claims against TOVALOP can be made only by national governments.

The oil industry expanded the scope of its liability with an agreement known as Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution (CRISTAL). CRISTAL increases the amount of liability per incident to a maximum of $30 million. Individuals as well as governments can present compensation claims to CRISTAL.

The harbor serves as the major log storage facility in Clallam County. Log utilization in Port Angeles in 1976 was (WDNR pers. comm. 1976):

Sawmills	48 million board feet
Shake mills	7
Plywood	20
Pulp	173
Export	267
Total	515

ITT-Rayonier uses logs in the production of pulp. Log storage is important to Crown Zellerbach's logging operations in other parts of the county. The companies have estimated the additional annual cost of dry land storage at $675,000 to $765,000 with initial outlays of $3 million for land and equipment (Crown Zellerbach pers. comm. July 1978). This cost would have a significant impact on the profitability of the local operations of these companies. Negotiations between the companies and NTPC are being conducted to reduce or eliminate these impacts.

Two additonal enlisted men would be required at the Coast Guard station pier in order to provide adequate marine safety (Coast Guard pers. comm. 1978).

Fire or explosion in the harbor area could cause substantial damage to vessels, berths, equipment and personnel including those at the Coast Guard facility (OIW 1979). A "worst case" tanker explosion could cause physical damages amounting to several thousand dollars along the Port Angeles waterfront. Physical damages at the Coast Guard Station could amount to several million dollars, the port facility ($59 million) and tanker ($60 million) would likely be destroyed.

Abandonment Phase

Employment with NTPC and employment generated by tanker operations would be lost. Temporary employment generated by tanker operations would be lost. Temporary employment might be created by the removal of facilities. The harbor area used for the port would become available for other uses. Resultant air quality improvement might permit industrial expansion.

Income

Construction Phase

Additional personal income generated during the initial construction phase would amount to about $29 million. This would be a significant positive impact on the economic welfare of providers of food, drink, rental housing, and other goods and services. The higher purchasing power of construction workers might cause temporary increases in prices of some goods and services which would be an adverse impact to some residents.

Rents are expected to increase during the construction period and return to normal once the demand had passed. Present renters might experience minimal impacts from increased housing costs during the peak period. Residents who move and newcomers would experience market pressures on mobile home spaces, motel and hotel rooms, and rental housing.

Residential properties near the site of the onshore storage facilities would be adversely affected by increased traffic, noise, and dust normally associated with construction. Potential buyers of property near the construction site may consider these properties less desirable. As a result, these land values might become temporarily depressed or appreciate at a slower rate than comparable land further away.

Operation Phase

Employment and procurement created by operation would generate about $2.6 million annually in local personal income. This is not a significant impact since it represents about 1 percent of total county income.

Power requirements would increase average costs for the Port Angeles and Clallam County utilities. See section 3.1 Transportation and Utility Networks. Additional power needs must be supplied from thermal sources. Under current pricing schedules power costs would be 1.16 cents per kwh from Port Angeles, and about 1.0 cents per kwh from Clallam County. Additional power would cost about 3.0 cents per kwh (BPA 1979). The differential between existing and additional power costs does not fairly represent an amount applicable to the project because load forecasts by both utilities project additional needs which will increase average power costs independent of the project. Unless power prices paid by NTPC equaled the costs of additional power supplies, other utility customers would bear a portion of the increased costs which could be significant.

The value of residential properties in close proximity to the onshore storage facilities would be adversely affected. The sale of adjacent land for residential use might become difficult because amenity levels play an important role in determining the value of residential property (NTPC 1978).

Shoreline property values would be adversely affected temporarily in the event of a major oil spill.

Abandonment Phase

Income generated during the operation phase would be lost.

Fiscal Conditions

Construction Phase

Sales tax is imposed on the value of construction (excluding engineering and construction management and environmental studies), at the place of construction (Washington Department of Revenue 1978). The tax on $147.5 million would amount to $737,000. Sales tax would also be collected on the expenditures of those persons deriving income from the construction. Expenditures are conservatively estimated at 54.8 percent of local workers' income and 27.4 percent (one-half the local rate) of non-local workers' income, or about 31.2 percent of the $28.8 million in personal income generated by the project. Sales tax collections on this amount would be about $45,000. Clallam County would receive an estimated $782,000 in sales tax revenues during the initial construction phase.

There would be increased needs for government services. Annual expenditure per pupil exclusive of space needs were estimated at $2,194 in 1977 (Port Angeles School District pers. comm. 1978). Additional space requirements would not exceed existing capacity except where existing needs already exceed capacity. No expenditures for additional space would be likely. Increased expenditures of school districts would be partially met by state government contributions. Crescent School District (313) would not have NTPC property within its jurisdiction; however additional expenditures required in that district would be minor. The increase in unreimbursed costs for Port Angeles District 121 and Sequim District 323 would be significant.

Road maintenance costs would be increased by construction traffic. Road administrative costs would also be increased by surveillance and policing of road use by contractors. The extent of damage and the amount of reimbursement for damage would partly depend on the effectiveness of road administration, but significant road damage costs would be likely.

Expenditures for new utility facilities required to serve the project would be recaptured out of subsequent utility operating revenues.

Additional expenditures for police and fire protection would also be required (see Social Conditions). Needs are estimated at three additional police and two fire personnel. It is not known which agencies might bear these expenditures.

Impact on the fiscal condition of local governments other than school districts could be significant if increased expenditures, especially road repair costs, substantially exceeded increased revenues for any separate government.

Operation Phase

Property taxes would accrue to state and local governments. The initial assessment value of NTPC property in Clallam County is estimated at $120.5 million. This value has been computed on the basis of construction costs as described in table 3.2-34. After the system had accumulated an operating history, assessed values would be determined on the basis of income value and depreciation. Assuming the construction cost represents the income value, the average assessed value over the project life might be about one-half the initial value.

Initial property tax collections based on the average levy of 15.49 mills in 1978 would amount to about $1.9 million. Amounts accruing to local governments have not been estimated.

Additional expenditures of local governments would be minor.

The substantial increase in property taxes would be a significant impact.

Abandonment Phase

The loss of NTPC property from the property tax base would be significant.

SOCIAL CONDITIONS

The social impacts of constructing the port and onshore storage facilities would be concurrent with construction of the Clallam County portion of the pipeline. Therefore, the portion of the pipeline within Clallam County is discussed in this section.

Population

Construction Phase

Manpower requirements for construction of the port and onshore storage facilities and onshore pipeline in Clallam County are listed in table 3.1-59. Construction and testing would take place over about 22 months.

A total induced population increase would be about 618 persons in Clallam County during peak construction and crowded conditions would occur as indicated in the preceeding Economics section.

Operation Phase

Resident population would be increased by about 300 persons. This is not likely to cause a significant impact.

Abandonment Phase

Abandonment of the port and pipeline facilities in Clallam County would not result in significant changes in population.

Infrastructure

Construction Phase

The number of housing or lodging units required to accommodate the maximum construction-related population would be about 74 family units and 544 single units or 618 total units. The average demand for housing during construction would be about 335 units. Maximum demand would exist for 4 to 8 months duration during peak construction. It is likely that some workers not accompanied by families would share accommodations. Housing needs could thus be reduced.

During the summer tourist season, housing would be in very short supply. Construction workers would compete with tourists for motel space and camping facilities. Adequate housing would exist during off-season, from October through May.

Escalation of rents could occur which would create a hardship on the resident population. The large retirement population living on fixed incomes would be adversely impacted by rent hikes.

The water and sewerage systems in Clallam County would not be significantly impacted during the construction phase of the project. Both systems have a capacity of at least 40 percent over current use.

The solid waste disposal sites would not be strained. Although capacity estimates are not available, the largest site should be able to accommodate the county's solid waste for about 50 more years (Clallam County Governmental Conference 1977).

The characteristics, including current pupil capacities and projected enrollments, of the three public school districts serving the area are summarized in table 3.1-60. Estimates of the number of school-age children that would be added to these systems because of the proposal are based on:

> About 48.9 percent of NTPC construction workers would bring families (NTPC 1978);
>
> There would be an average of 1.61 children per family;
>
> About 58.2 percent are assumed to be in the 5 to 17 age bracket;
>
> Children of NTPC employees would enroll in the public school system;
>
> Children aged 5 to 17 are distributed uniformly among the 13 primary and secondary grades (K through 12).

NTPC is expected to relocate approximately 335 workers in the area; 147 would bring families. About 137 pupils would be enrolled in the public schools of three school districts. Distribution of these students among the area's elementary, junior high, and senior high schools is shown in table 3.1-60.

> Enrollment increases caused by NTPC would be from 1.2 percent to 2.8 percent of projected baseline 1980 enrollment in the Port Angeles and Sequim Districts, or 0.7 percent of projected 1980 enrollment in the Crescent District. There are significant capacity problems projected for elementary schools in the

TABLE 3.1-60 PROJECTED CONSTRUCTION IMPACT OF NTPC ON PUBLIC PRIMARY AND SECONDARY SCHOOL ENROLLMENT IN CLALLAM COUNTY

School District	Type of School 1/	Grades	Existing Capacity 2/	Project Enrollment				Present Increase in Enrollment due to NTPC Proposal	
				Total without NTPC		NTPC induced 3/			
				1980	1982	1980	1982	1980	1982
Port Angeles	E	K-5	51	2,114	2,211	41	22	1.9	1.0
	J	6-8	1,276	1,050	1,150	20	11	1.9	1.0
	S	9-12	1,587	1,508	1,412	28	16	1.2	1.1
Crescent	E	K-6	110	152	160	1	1	0.7	0.6
	J/S	7-12	214	148	169	1	0	0.7	0.0
Sequim	E	K-4	122	600	630	17	11	7.8	1.7
	J	5-8	354	604	614	13	10	2.2	1.6
	S	9-12	760	637	660	13	10	2.0	1.5

1/E = elementary, J = junior high school or middle school, S = high school.
2/Future capacity is assumed to be the same as existing capacity, except in Sequim District where modernization and expansion of elementary school is due to be completed in August, 1979, with new capacity in grades K to 4 for 600 pupils. Similar expansion of the middle school is planned for completion in 1980 and 1981, with new capacity total of 620 seats, depending on when expansion is completed.
3/Although NTPC construction would not begin until 1981, impacts would be similar.

TABLE 3.1-61 POLICE PROTECTION IN CLALLAM COUNTY

	1978	Number of Full-Time Officers per Thousand Residents Served 1/ Based on 1978 Staffing Figures (1977 for Clallam County Sheriff's Department)			
		1980 2/		1982	
		Without Project	With Project 3/	Without Project	With Project 3/
Port Angeles Police Department	1.18	1.10	1.08	1.06	1.05
Sequim Police Department	2.00	1.83	1.77	1.75	1.74
Clallam County Sheriff's Department	0.87	0.80	0.79	0.77	0.77

Source: NTPC 1978
1/Residents in municipality for municipal police departments, residents in unincorporated areas for county sheriff's departments.
2/Although NTPC construction would not begin until 1981, impacts would be similar.
3/Ratio based on peak population due to NTPC.
National averages for number of officers per thousand residents served are as follows: Towns under 10,000 population - 1.8; towns between 10,000 and 25,000 population - 1.6; county sheriff's department - 1.5 (FBI 1976).

Crescent and Port Angeles Districts, as well as for the junior high school in the Sequim District. This is based on the assumption that no additional classroom would be provided. Enrollment increases induced by NTPC would aggravate existing classroom shortages. Additional expenditures by the districts could be required to provide transportation, furniture, textbooks, and other instructional materials for the incoming students.

The Hill-Burton standards used by hospitals requesting federal aid were used to determine future hospital bed needs. Service statistics of the three hospitals in the area were combined. Based on the Hill-Burton standards, the population growth associated with construction and operation of the NTPC would have no significant impact on existing hospital facilities. On the average, only one additional bed per day would be required by NTPC construction-related population, and 49 vacant beds would be available.

Assuming no increase in the number of primary care physicians, the level of primary health care service would remain adequate through 1982, including NTPC project-related population growth. A physician to resident ratio of 1 to 2,000 is considered adequate; 1 to 3,500 and less is considered inadequate. Projected ratios for 1982 are 1 to 2,093 without the proposal and 1 to 2,106 with the NTPC proposal.

Potential impacts on law enforcement from NTPC-related population growth have been estimated by calculating the ratio of officers to population served both with and without the proposal, assuming no growth in the staff of these agencies (see table 3.1-61). Except for the Sequim Police Department, all agencies show current and future police-to-resident ratios below national averages. The influx of NTPC-related residents would have a small, incremental adverse effect.

The total peak construction-related population of 1,507 persons would generate a short-term need for about three additional officers within the area. This conclusion is based on the national staffing averages of 1.5 to 1.8 officers per 1,000 residents. In addition, the traffic generated by construction workers and deliveries of materials to the construction sites might result in a need for officers to be stationed at major access roads.

The likelihood and potential impact of fire and explosion at both the tanker unloading facilities and onshore storage facilities are addressed in section 3.1 Oil Spill, Fire, and Explosion Risk Analysis. While the calculated probabilities of fires are low, such occurrences might result in calls for assistance to municipal fire protection agencies.

Population growth caused by construction of the NTPC proposal would slightly increase the existing need for additional fire fighting personnel. One or two fire fighters would be necessary over the present needs. These estimates are based on projected peak population growth.

Operation Phase

Housing needs associated with the 20-year operation phase of the port and onshore storage facility would not have a significant impact. Approximately 95 homes would be purchased during this period, which would be available on the Port Angeles market.

No significant effects would occur on the water or sewerage systems. Solid waste services would also not incur a significant impact except in the case of a large oil spill. Oily wastes would require special handling and disposal. If the existing landfill is satisfactory for disposal of oily wastes, management plans for operation of the site would need to be substantially modified to accommodate any large quantity of oil waste material.

During the operation phase, it is estimated that there would be 61 school age children enrolled annually in the three school districts. This would result in an average 0.5 percent increase over projected 1980 and 1982 enrollments, causing minimal impacts.

There would be no impacts on medical facilities or physician to resident ratios as explained under the construction phase.

The influx of newcomers during operation would add slightly to the existing shortage of law enforcement personnel as measured by national averages.

Population increases and operation of the proposed port and onshore facilities would not cause a need for any additional fire protection. However, the proposal would further aggravate the existing shortage of fire fighting personnel.

An explosion at the port facility could incapacitate the fire boat. This would significantly detract from available fire fighting capability should a fire ensue.

Abandonment Phase

Assuming continued growth in the local economy, the sale of homes by NTPC personnel and others leaving the area would not significantly affect housing conditions.

No significant effects will be felt on the water, sewerage, or solid waste systems in the county.

Abandonment of the project would result in a approximate 0.5 percent decline in school enrollment.

There would be no impact on medical facilities or services.

Abandonment would have no adverse effects on police or fire protection in Port Angeles and Clallam Counties.

Native Americans

No significant impacts are anticipated to occur on the infrastructure of the Lower Elwha Tribal Community or the Makah Reservation.

Social Well-Being and Quality of Life

Construction and Operation Phases

Since the number of persons coming into the area for employment in the construction and operation phases of the project would be minor in comparison to the total projected population, there would be no significant direct impacts. There would be important indirect impacts.

Age distribution patterns would be affected. Construction and operation of the port and onshore storage facilities would adversely affect the scenic and recreational attractiveness of the harbor. This, in turn, might reduce the number of retirees who are presently projected to move into the region.

In contrast, a higher proportion of young adults would remain in the city and county. The construction and operation of the proposed project would offer incentives for actual or potential jobs.

Since the majority of persons involved in construction and operation of the port and onshore storage facilities would be skilled workers, unemployment rates in the county would not be significantly reduced.

Operation of the project might affect industries presently employing residents. Employment in the wood products industries, fishing, and boat repair firms might be limited to approximately present levels due to NTPC proposal.

Increased demands would be placed on the city and county for long-range planning. Petroleum-related industries might express interest in locating in the county or city. To the extent that this type of interest might occur, planners would be involved in studying, planning, and implementing revisions to planning and zoning regulations.

Construction and operation of the port might alter the importance of the harbor in the lifestyle of residents. Private ownership of pleasure boats might be of less concern among residents as restrictions to harbor use increase.

Increased use of Highway 112 might occur as boaters and anglers travel west of Port Angeles to escape harbor restrictions. This, in turn, would impact the level of use of the recreational sites to which the highway provides access.

Regardless of compliance with air and water quality standards, and regardless of the content of monitoring reports, residents might feel that air and water quality of the region has diminished.

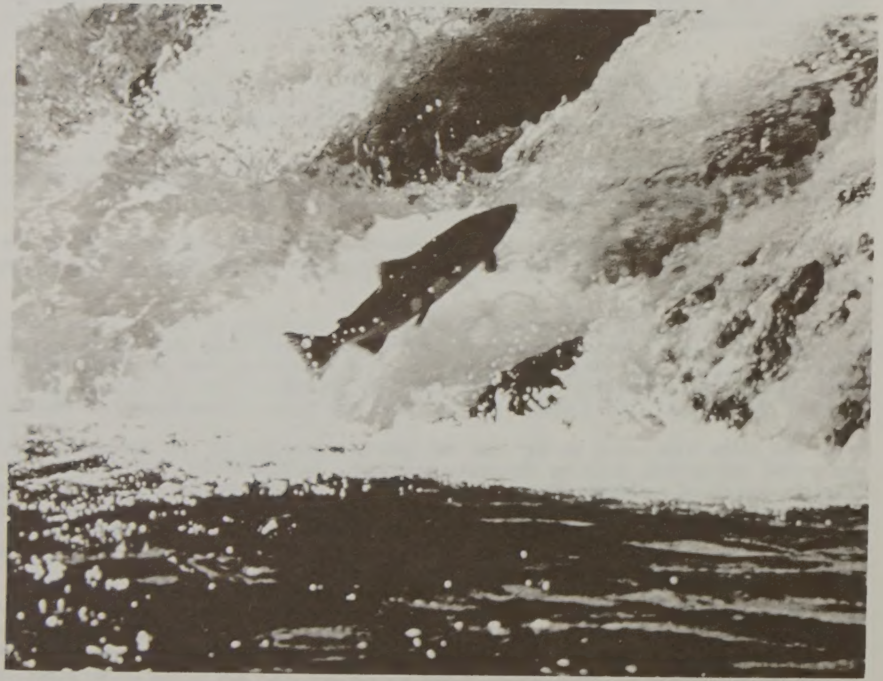
There would be direct impacts on perceptions of the residents of the city and county as a "place to live." Many view this proposal as an irreversible step toward further industrialization. Some residents believe it would stimulate other petroleum related development. In connection with this they see population and employment growth, housing development, and drastic changes from the present small-town atmosphere.

Those who place high value on the city and county as a place to live because of this small-town atmosphere would be adversely impacted. To the extent that these values preclude continued residence in an area undergoing urbanization, these people will be forced to move or to redefine their values. Prior to doing either, however, they would probably launch attempts to prevent additional petroleum-related industries from coming to the area. Such attempts, if they are not reflective of the feelings of the local majority, can be divisive for a community.

The proposal itself would have a relatively insignificant impact on the city and county as a "place to live." However, it represents a change factor of considerable significance. This factor, an industry that can justify the presence of other industrial investment or development, would impact the city and county as a "place to live."

The construction phase would have minimal impacts on the social well-being of the Makah and Lower Elwha Tribal Community Reservations. However, the operation phase would involve adverse impacts to the fishing enterprises if major oil spills occurred.

Operation of the port, with an increase in tanker traffic, an increase in demand on electric power, and the possibility of spills, would represent competition for the same types of resources needed for fish enterprise expansion. An oil spill would have serious impacts on fish harvest, with possible long-term consequences on Native American income and employment.



Coho salmon

U.S. Fish and Wildlife Service

3.2 Pipeline System

OIL SPILL, FIRE, AND EXPLOSION RISK ANALYSES

Pipeline Oil Spill Risk

Because underwater and onshore environments differ so greatly, spill risks for offshore and onshore pipelines were analyzed separately. Major causes of onshore pipeline spills are internal corrosion, faulty equipment, faulty pipe, breakage of pipe by construction equipment, natural disaster, personnel error, and sabotage. In addition to these, underwater pipeline spills can result from damage caused by anchors, fishing gear, and external corrosion.

For calculating both onshore and underwater spill rates, pipeline mileage was selected as the exposure variable. Although volume throughput would have been preferable as the exposure variable, insufficient data precluded its use. Based on historical rates it is estimated that the annual spill rate for the onshore pipeline would be 0.0022 spills per mile with 95 percent confidence limits of 0 to 0.0046. The offshore annual spill rate is estimated at 0.00084 spills per mile with 5 percent confidence limits of 0.00025 to 0.00143.

Estimated spill frequencies are expressed as "one spill every 'X' years," but do not indicate when the spill might occur. Spill probabilities will be valid only as long as conditions remain the same as those upon which the historical pattern and estimates are based.

Using the historical spill rate for onshore pipelines (spills per mile), the probable risk for existing lines in the greater Puget Sound area is one spill equal to or greater than 2.4 barrels every 1.19 years. Estimated spill magnitude frequencies for these pipelines are presented in table 3.2-1.

During the expected 20-year life of the NTPC project, about 3.8 spills equal to or greater than 2.4 barrels (or one every 5.2 years) could be expected from the 128-mile pipeline segment between Green Point and North Bend, Washington. The 95 percent confidence limits indicate that as many as eight or as few as zero could occur. Estimated spill magnitude frequencies for the NTPC increment in greater Puget Sound are given in table 3.2-2.

The quantity of oil spilled each year by on- and offshore pipelines can be estimated using the frequency of spill occurrences and their representative volumes. The average annual spill volume from existing pipelines in greater Puget Sound is estimated to be 523 barrels. That for the proposed NTPC segment between Green Point and North Bend, Washington would be 111 barrels, giving a combined average annual spill volume in greater Puget Sound of 634 barrels.

Approximately 61 onshore oil spills equal to or greater than 2.4 barrels could be expected between North Bend, Washington, and Clearbrook, Minnesota during the life of the project. Within the 95 percent confidence limits, this number could vary from zero to 128 spills.

For the entire NTPC pipeline length the frequency of spills equal to or greater than 2.4 barrels would be approximately one every 112 days.

TABLE 3.2-1 ESTIMATED PIPELINE SPILL MAGNITUDE FREQUENCIES
FOR EXISTING PIPELINES GREATER PUGET SOUND AREA
(For Spills(≥) 2.4 Barrels)

Spill Size (barrels)	Spill Frequency and Uncertainties 1/
	One spill every:
2.4 - 10	3.2 years (1.5- -)
10.1 - 100	2.3 years (1.2- -)
101 - 1,000	9.5 years (4.7- -)
1,001 - 10,000	45.8 years (21.9- -)
10,001 - 100,000	396 years (190- -)
A spill (≥) 2.4	1.19 years (0.57- -)

Source: OIW 1978 a,b

1/ Figures in parentheses are based on 95 percent confidence limits of the derived historical pipeline spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all pipeline spills. Upper limits are unpredictable and indicated by the dash.

TABLE 3.2-2 ESTIMATED PIPELINE SPILL MAGNITUDE FREQUENCIES
FROM PROPOSED NTPC PIPELINE--GREEN POINT TO NORTH BEND 1/

Spill Magnitude (barrels)	Spill Frequency and Uncertainty 2/
	one spill every:
2.4 - 10	13.2 years (6.5- -)
10.1 - 100	11.5 years (5.5- -)
101 - 1,000	44 years (21- -)
1,001 - 10,000	167 years (91- -)
10,001 - 100,000	1,111 years (500- -)
A spill (≥) 2.4	5.2 years (2.5- -)

Source: OIW 1978 a, b

1/ Calculated for 108 miles of onshore and 20 miles of offshore pipeline.

2/ The ranges shown in parentheses for each spill magnitude category are estimates of the 95 percent confidence limits and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills. A dash (-) signifies no limit could be computed.

Pipeline Station Fire and Explosion

Although precautions would be taken to prevent pipeline station fires and explosions, these events could occur. Potential causes are those described for onshore storage facilities in section 3.1 Oil Spill, Fire, and Explosion Risk Analyses.

Estimated frequencies and fire damage magnitudes are based upon American Petroleum Institute (API) historical data (see section 3.1 Oil Spill, Fire, and Explosion Risk Analyses). The estimated frequency of a fire causing damage equal to or greater than $1,000 at any one pipeline station is estimated to be one every 264 years, with 95 percent confidence limits of 200 to 396 years. At ultimate throughput (933,000 barrels per day) the NTPC pipeline system would utilize 21 stations. Table 3.2-3 provides estimates of fire frequencies and magnitudes.

TABLE 3.2-3 ESTIMATED FREQUENCIES OF FIRE DAMAGE
FOR PROPOSED NTPC PIPELINE STATIONS 1/
(933,000 barrels per day throughput) 2/

Fire Damage Magnitude	Fire Frequency and Uncertainty 2/
	one fire every:
$ 1,000 to $10,000	24 years (18 to 36)
$ 10,000 to $100,000	19 years (30 to 59)
$100,000 to $500,000	97 years (73 to 145)
over $500,000	632 years (476 to 943)
A fire (≥) $1,000 damage	13 years (10 to 19)

Source: OIW 1979

1/ For 21 stations, although during the initial throughput phase of the project only 18 stations would be constructed and operating.

2/ For fires causing damage over $1,000. Ranges shown in parenthesis are estimates of the 95 percent confidence limits and were calculated assuming that the variance of each fire magnitude category was equal to the variance of the data for all fires.

The subsurface and submarine pipelines have little explosive potential. However, the pipeline is above ground at pumping stations. An oil or vapor leak at this point could ignite in a variety of unlikely yet possible ways, such as by an accumulation of static electricity, lightning, or sabotage. If vapors accumulate in an empty pressure relief tank at a pump station and a source of ignition exists, an explosion could occur. The volume of an empty relief tank is about 112,000 cubic feet. The magnitude of such an explosion would be equivalent to 5.8 tons of TNT. The fireball radius would be 11.5 feet. There would be approximately a 16 percent chance of fire spreading to the pump units. Table 3.2-4 gives the distances for various human injuries and structural damages that could be expected from a pump station explosion.

A further refinement of explosion damage estimates was prepared for tanker and onshore storage facility explosions (see 3.1), but was not completed for possible pipeline station explosions. The refined analysis extended the ranges within which damages to structures could be expected, while ranges within which human injuries could occur are similar.

TABLE 3.2-4 5.8 EQUIVALENT TONS OF TNT EXPLOSION
(Possible Pipeline Station Explosion)

DISTANCES FOR VARIOUS BLAST INJURIES

Injury	Distances (ft.) 1/
Mostly safe (whole body)	331
Skull fracture threshold	287
Fracture feet and legs	265
Skull fracture near 50% probability	243
Lethality threshold (whole body)	230
Skull fracture near 100% probability	217
Lethality near 50% probability (whole body)	199
Lethality near 100% probability (whole body)	177

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCURES

Type of Structure	Distance for Moderate Damage 1/	Distance for Severe Damage 1/
1. Wood-frame building	487	350
2. Multistory, wall-bearing buildings, brick apartment house type	364	256
3. Multistory, wall-bearing buildings, monumental type	243	189
4. Multistory, blast-resistant design, reinforced-concrete buildings	108	81
5. Multistory, reinforced-concrete buildings, with concrete walls and small window area	216	135
6. Highway truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	121	88
7. Multistory, reinforced-concrete frame office type buildings, earthquake resistant.	121	88
8. Light steel-frame buildings	202	121
9. Heavy steel-frame industrial buildings (25- to 50-ton crane)	175	108
10. Heavy steel-frame industrial buildings (60- to 100-ton crane)	148	94
11. Railroad truss bridges of 150- to 250-foot span (blast normal to longitudinal bridge axis)	148	94
12. Multistory, reinforced-concrete frame office type building	148	94
13. Highway and railroad truss bridges of 250- to 400-foot span (blast normal to longitudinal bridge axis)	148	94
14. Multistory, steel-frame office type buildings,	121	88
15. Multistory, steel-frame office type buildings, earthquake resistant	108	74

TABLE 3.2-4 (Continued)

DAMAGE-DISTANCE RELATIONSHIP FOR VARIOUS STRUCURES

Source: OIW 1979 (Rev)
1/ After correction for surface/air burst.

AIR QUALITY

Construction Phase

Main Line Stations

Emission rates from construction of a typical pump station or pressure reducing station are listed in table 3.2-5. All rates were based on emission factors developed by the Environmental Protection Agency, AP-42 (EPA 1977). These figures represent peak emission rates. Therefore, actual would be less during most of the 12-month construction period.

All gaseous emissions would be produced by combustion engines of construction equipment and vehicles. Impacts from the vehicle emissions would be confined to the immediate vicinity of the construction site. Pollutant concentrations would be very small and would be well within ambient air quality standards.

TABLE 3.2-5 ESTIMATED POLLUTANT EMISSIONS FROM CONSTRUCTION
OF A TYPICAL PUMP STATION

Pollutant	Emission Rate (lb/working day)
Nitrogen oxides	660
Carbon monoxide	160
Hydrocarbons	46
Sulfur dioxide	46
Particulates	27
Fugitive dust	500

Source: SAI 1978

Fugitive dust emissions would result from disturbance of the soil. It is assumed that about 6-7 acres of soil would be disturbed per site.

In general, impacts from fugitive dust would tend to be lowest in western Washington and highest in eastern Montana and North Dakota. Fugitive dust would usually be limited to the immediate vicinity of the construction site, except during dry and windy conditions.

Pipeline

Emissions from pipeline construction are listed in table 3.2-6. It is assumed that there would be a 4 to 8 mile long ditch with construction spread over a distance of 8 to 16 miles, for 2 weeks to 1 month. Fugitive dust emissions would result from grading, trenching, and backfilling as well as the operation of vehicles on unpaved roads. Emission levels would depend on local soil conditions and weather, and would tend to be lowest in western Washington and highest in Montana and North Dakota. Pollutant emissions from vehicles would be slight and confined to the immediate vicinity of the construction site.

TABLE 3.2-6 ESTIMATED POLLUTANT EMISSIONS FROM PIPELINE CONSTRUCTION

Pollutant	Emission Rate (lb/working day)
Nitrogen oxides	4,400
Carbon monoxide	1,400
Hydrocarbons	310
Sulfur dioxide	290
Particulates	190
Fugitive dust	7,700-11,000

Source: SAI 1978

Delivery Facilities

Emission rates for a typical delivery facility would be about the same as those for the onshore storage facility (table 3.1-33). Fugitive dust emissions would be higher for delivery facilities proposed for Montana and North Dakota than for the one at Clearbrook because of generally drier conditions. Impacts would be similar to those for the storage facility at Green Point.

Operation Phase

Main Line Stations

The only pollutants emitted from a typical pump or pressure reducing station during the operation phase would be hydrocarbons from the surge tank, if one were installed. Hydrocarbon concentrations near the proposed facilities would ordinarily be negligible.

Pipeline System

Emissions from the proposed pipeline would be negligible during the operation of the pipeline and no significant air quality impacts would be expected.

Delivery Facilities

Hydrocarbons would be emitted by storage tanks at the intermediate delivery facilities. Hydrocarbon emissions would not be sufficient to produce ozone. The emissions for each of the proposed facilities are listed in table 3.2-7.

A fire or explosion anywhere in the proposed pipeline system would cause a temporary emission of significant quantities of air pollutants. The area of impact would be relatively small. Visibility would be affected by a cloud of black smoke that could be visible for several miles.

Atmospheric emissions for the proposed delivery facility near Clearbrook, Minnesota, would also be hydrocarbons from the storage tanks. Additional storage required at that facility would increase annual emissions by 85 tons per year over the estimated 175 tons per year from the existing facilities (SAI 1978).

TABLE 3.2-7 ESTIMATED HYDROCARBON EMISSIONS, DELIVERY FACILITIES

Delivery Facility	Annual Emission Rate (Tons/Year)	Worst-Case Emission Rate (lb/hr)
Glacier	25.4	9.4
Western Crude	18.3	7.2
Amoco	9.1	3.7
Clearbrook	85	NA

Source: SAI 1978

Emissions could occasionally exceed federal guidelines for hydrocarbons near the proposed facility. However, since ozone modeling for the Port Angeles area indicated only a negligible effect on ozone, it could be expected that the proposed storage facility at Clearbrook would have a similarly negligible effect on ozone.

Abandonment Phase

Air quality impact would be similar to those incurred during construction. No significant impacts are anticipated.

NOISE

Construction Phase

Main Line Stations

During the construction of a pump station, significant noise sources would be cranes, dozers, backhoes, tractors, and welding machines. Construction would take place over a period of about 12 months.

Residences located 1,500 feet from the construction site would experience equivalent noise levels of about 70 dBA. This would be a significant increase above background levels for rural locations and might cause some annoyance. Residences located 4,000 feet from the construction site would experience noise levels of about 55 dBA.

Most of the pump stations would be located away from residential areas. Scattered single residences would be affected along the proposed pipeline route, with some residences experiencing noise levels of up to 70 dBA. Since construction would take place only in the daytime, minor adverse impacts would be expected.

Pipeline

The impact of pipeline construction noise would be temporary. The intensity of the impact would depend on the distance of the receptor from the noise source. Duration of the impact would depend on the rate at which construction proceeded. In rural areas, construction would move more quickly than in suburban or urban areas. However, since rural background noise levels are lower than in residential areas, construction noise would be more noticeable, diminishing the advantages of shorter duration. Conversely, although duration would be longer in urban areas the greater background noise would make the increase less noticeable.

For the purposes of noise calculation, it is assumed that pipeline construction would proceed at the rate of about 1,500 feet per day. This rate may be faster or slower depending on local conditions. Construction would consist of trenching, clearing, grading, and pipe stringing operations, followed by bending, welding, pipeline lowering, and backfilling. Typical construction machinery that would cause noise would be backhoes, motor cranes, and front end loaders. Construction would be limited to the daytime.

Table 3.2-8 shows the expected maximum daytime noise levels and expected duration of impact. Noise intensities are derived from a modeling study performed for the proposed SOHIO pipeline project (SOHIO 1977). Noise increases would generally be noticeable for residences located within 2,500 feet of the proposed pipeline route. Noise levels would generally be noticeable for less than 5 days. At distances of 500 feet or less, there would be a period of 1 or 2 days when the level would exceed 65 dBA. It might be annoying to some residents, but would be of limited duration.

Delivery Facilities

Noise levels would be similar to those for the construction of the onshore storage facility at Green Point. The intermediate delivery facilities would be located away from any residences and therefore no impact would be expected.

TABLE 3.2-8 NOISE LEVELS DURING PIPELINE CONSTRUCTION

County and State	Location	Type of Receptor	Approximate Distance to Nearest Receptor, Feet	Maximum Expected Noise Level at Nearest Receptor Point dBA[1]	Approximated Duration (days) of Noise Levels Greater Than 50 dBA at Nearest Reception Point
Island, WA	Oak Harbor	Residences	500	67	5
Snohomish, WA	Stanwood	Residential	500	67	5
	E. Stanwood	Residential	500	67	5
	Arlington	Residential	1,000	62	5
King, WA	North Bend	Residential	500	67	5
Grant, WA	South Ephrata	Recreational	500	67	5
Lincoln, WA	Sprague	Residential	1,000	62	5
Benewah, ID	Plummer	Residential	1,000	62	5
Shoshone, ID	Kingston	Residential	500	67	5
	Murray	Residential	500	67	5
Sanders, MT	Paradise	Residential	2,500	54	4
	Missoula	Residential	500	67	5
Clark, MT	Helena	Residential	500	67	5
Broadwater, MT	Townsend	Residential	500	67	5
Williams, ND	Williston	Residential	500	67	5
	Epping	Residential	500	67	5
Mountrail, ND	Stanley	Residential	2,000	57	4
Ward, ND	Berthold	Residential	500	67	5
McHenry, ND	Towner	Residential	1,000	62	5
Pierce, ND	Rugby	Residential	2,000	57	4
Benson, ND	York	Residential	3,000	52	3
	Leeds	Residential	500	67	5
Ramsey, ND	Church's Ferry	Residential	1,000	62	5
	Penn	Residential	500	67	5
	Doyon	Residential	2,000	57	4
	Crary	Residential	500	67	5
Nelson, ND	Lakota	Residential	1,000	62	5
	Michigan	Residential	1,000	62	5
	Petersburg	Residential	500	67	5
Grand Forks, ND	Arvilla	Residential	2,000	57	4
	Grand Forks	Residential	3,000	52	3
Clearwater, MN	Clearbrook	Residential	2,000	57	4

[1] A-weighted decibel.

Noise levels associated with the proposed expansion of the existing storage facility at Clearbrook, Minnesota, would be similar to those related to the construction of the proposed storage facilities near Green Point. Noise levels could approach 65 dBA in some residential areas in Clearbrook. However, construction would take place during daytime only, and the levels would be within the state of Minnesota standards.

Operation Phase

During the operation phase the primary source of noise along the pipeline would be the pump stations. A typical station would be equipped with electrically driven pumps that would produce a noise level of 69 dBA at a distance of about 100 feet. At 1,500 feet the equivalent level would drop to about 45 dBA, which is not likely to cause annoyance. At distances beyond 4,000 feet noise would be below background levels.

Abandonment Phase

Noise impacts during the abandonment process would be similar to those caused by construction.

TOPOGRAPHY AND GEOLOGY

Topography

Construction Phase

The primary topographic impact would be visual (see section 3.2 Visual Resources) and would consist of varying degrees of landform alteration resulting from construction activities. This would be most pronounced along the coastal bluffs of the Puget Trough--Port Williams (pipeline mile 11.6), Partridge Point (pipeline mile 30), and Brown Point (pipeline mile 50.5) and in areas of high relief such as the Cascade Range (pipeline mile 122.9 to 260) and the Northern Rocky Mountains (pipeline mile 360 to 757) where slopes often reach 30-60 percent (or more).

Based on an average horizontal working platform 100 feet wide, landform alterations would average about 12 acres per mile in gentle terrain and 15 to 35 acres per mile (depending upon slope steepness) in mountainous areas (assuming back slopes of 3 to 1 in loosely consolidated to poorly cemented material). Grading and leveling would alter up to 6 or 7 acres for each pump station and about 5 acres for the delivery facilities at Clearbrook, Minnesota.

Excavating and grading for the pipeline could block or divert small surface drainages and result in impacts of 1 month or less duration. Settlement of backfill on the pipeline trench would impact the topography along the entire route by disrupting sheet-flow drainage patterns and directing surface waters thus increasing erosion potential.

Temporary topographic impacts could occur where pipeline trenching crossed river channels. These open trenches would affect bed configuration that could increase streamload, bank erosion, and scour. Once the pipeline was installed and the trenches closed, most streams would probably return to their original condition. This impact would be most severe along the major streams, including the Columbia, Missouri, and Clark's Fork Rivers, because of their high streamflows.

Operation Phase

Normal operation of the pipeline system would have no identified impact on the topography. A fire or explosion would have no impact on topography.

Abandonment Phase

With the exception of the Cascade Range and Northern Rocky Mountains, the proposed pipeline system would traverse relatively gentle terrain. Consequently, abandonment and restoration would return most of the land to approximately its original condition. However, in mountainous areas and along coastal bluffs where extensive cutting was required or where blasting was done, scars would be permanent.

Geology

As mentioned in chapter 3, there would be no impacts to the geology caused by constructing NTPC's proposed pipeline. Rather, there would be potential impacts to the project that could be caused by geologic events which could result in oil spills. These impacts, in turn, could affect other resources, particularly water quality, organic matter, and scenic quality.

Although earth scientists can often predict where potential exists for a catastrophic geologic event, the time or magnitude of such an event cannot be forecast with any degree of reliability (USGS 1978). As the magnitude of most geologic events cannot be quantified the following qualifying terms will be used whenever quantification is not possible (see also section 3.1 Topograpy and geology):

Insignificant: No discernible damage to the pipeline system.

Significant: Damage to the pipeline system warranting repairs, but no resultant oil spill.

Critical: Damage to the pipeline system resulting in an oil spill.

Construction Phase

Construction of the pipeline would have a minor impact on geologic materials that would be encountered (see Map Addendum and section 2.1 Topography and Geology for description). Activities would be limited to the removal and replacement of large amounts of material and some alteration of physical characteristics by excavation, including blasting.

The amount of geologic material removed during trenching would vary with the type of material (e.g. loose sediments or crystalline rock) and with the terrain.

Effects of blasting would depend on the rock type. Crystalline rock could fracture extensively, weakening the inherent strength of the surrounding bedrock and slightly increasing the potential for slope failure, particularly in the steep terrain of the

Northern Rocky Mountains. In other rock types, such as well-cemented sedimentary rocks and large boulders (found scattered throughout unconsolidated glacial and alluvial deposits), blasting would probably not weaken the structure of surrounding areas. Blasted material would not generally be suitable for backfilling and would have to be deposited at fill sites.

Operation and Abandonment Phases

Operation and abandonment of the pipeline system would have no identified impact on the geology. There would be no impact to the physical geology as a result of fire or explosion.

Geologic Hazards

Construction Phase

The only geologic hazard anticipated during the construction phase is slope instability. Trench excavation and access road construction on slopes exceeding 50 percent could create unstable cutslopes and could reactivate old slides. Overloading the tops of slopes with fill or undercutting the toes would contribute to instability. Ground vibrations set off by blasting could induce rockfalls or landslides on steep or saturated slopes. These landslides could involve new areas or reactivate old ones.

Slope movements could range in magnitude from small rock falls involving only a few hundred cubic feet of material to massive slides involving several thousand cubic yards of material and covering several acres of land. These would be most likely to occur in areas of existing slope instability. The Map Addendum shows that moderate to large magnitude slope movements are most probable along the coastal bluffs in the Puget Trough, particularly Port Williams (pipeline mile 11.7), Partridge Point (pipeline mile 30), and Brown Point (pipeline mile 50.5); Cascade Range (pipeline mile 129 to 143), near the Columbia River (pipeline mile 222 to 227); and along Siegel Creek (pipeline mile 500 to 510). Slides could cause loss of life, structures, utilities, and construction equipment as well as modification of vegetation, topography, and drainage.

Operation Phase

Volcanic activities such as eruption, volcano-induced flooding, and mudflows, are possible in the Cascade Range, but would most likely bury the line and not cause a rupture. Because such volcanic events occur very infrequently (500 to 10,000 years apart) their probability is considered very slight.

Swelling clays (i.e., bentonite) and subsidence would result in a slight bending of the pipe, with little or no damage; impacts resulting from these geologic hazards would be minimal. As the pipeline would be buried below frost level and heated to 35-40° F by the moving oil, frost heaving would not be a problem.

Seismic-related activities (surface fault rupture, ground shaking, liquefaction), slope instability, and outburst flooding are the only geologic hazards considered capable of producing significant or critical impacts on the pipeline system during operations.

Rocky Mountains in Montana

Bureau of Land Management

Seismicity.

Surface-Fault Rupture. Fault movement, particularly that which ruptures the surface, would be a potential cause of pipe distortion where the pipeline crossed active or potentially active faults. If distortion were great enough, the pipe could rupture and cause an oil spill ranging from a few barrels to several thousand, depending upon the distance between block or check valves. Although two active faults (Prickly Pear and Scratch/gravel Hills, both near Helena, Montana, pipeline mile 650 to 655) are located near the pipeline corridor, only Prickly Pear would be crossed by the pipeline (see Map Addendum). Two earthquakes (6.0 and 6.25 Richter) have occurred on this fault within the past 50 years. The potential for ground surface rupture and an oil spill resulting from a pipe rupture would be high (Fugro 1978) and could damage up to 5 miles of pipe.

Of the 17 potentially active known faults near the pipeline, only seven would be crossed by it. Like the Prickly Pear Fault, they could possibly rupture the pipeline causing an oil spill. However, as these faults have shown no surface movement in historic time the probability of such movement in the life of the project is considered to be quite low.

There are seven possible faults along the proposed NTPC route, three of which would be crossed by the pipeline. An impact assessment of these is not feasible at this time as they have not yet been definitely identified as faults. They have been included in this document to draw attention to the need for more detailed study of geologically or geophysically anomalous items that might represent potential hazards. The Map Addendum depicts these known and inferred faults.

Ground Shaking. Ground shaking could affect operation of support and emergency equipment intended to minimize problems associated with failure. Power or communication facilities needed to prevent or contain impacts caused by a pipeline failure due to seismic activity, could itself be damaged by the severe earthquake intended to assist in preventing or containing (Fugro 1978).

Ground shaking could cause failure of tanks, of connections between components of the system, of pump stations and control buildings, and of the pipe itself. The ultimate adverse impact would be the failure and rupture of some part of the system leading to an oil spill. Study of regional tectonics shows that the most important seismic event that could reasonably be expected on the fault nearest the pipeline is the contingency level earthquake (CLE). The CLE has a very low probability of being exceeded during the life of the project. Critical facilities are commonly designed so that substantial deformations may occur during a CLE without causing ruptures. Consequently, a rupture of the NTPC system is not expected during induced ground shaking (Fugro 1978a). Although final design criteria have not been developed, NTPC has indicated that an evaluation of earthquake risk potentials--expected frequency, magnitude, location--would be made for the various segments of the route and detailed seismic risk studies conducted for seismically active areas (i.e., zone 3 seismic risk).

Strong seismic ground shaking has been reported in the Cordilleran system since the early 19th century, particularly in western Washington (Puget Trough) and western Montana (intermountain seismic zone), where earthquake intensities of up to Modified Mercalli IX have occurred. Potential for earthquakes in these two regions is thus high and they are classified in the 1976 Uniform Building Code as Seismic Risk Zone 3 (see Map Addendum). The remainder of the western portion of the proposed line (to about pipeline mile 757) is in seismic risk zone 2 and has a moderate potential for ground shaking. The eastern portion of the route (from pipeline mile 757 to the delivery facilities at Clearbrook, Minnesota) has a very low incidence of seismic activity. Consequently the potential for ground shaking is low.

Liquefaction. Liquefaction of bearing soils (and/or sediments) along the route could contribute to failure of the pipeline and result in an oil spill. It is the seismic-related impact that is most likely to occur. It is caused by the liquefaction of soft soils or sediments on either side of more rigid material (such as bedrock), which forces the pipe into a small-radius double curvature. Liquefaction is associated with seismic activity and is limited to the western portion of the pipeline, particularly, the Puget Trough, the Cascade Range, and the Northern Rocky Mountains (see Map Addendum).

In steeper locations, liquefaction could result in slope instability leading to sufficient downslope movement of the pipe to cause rupture. Specific locations where liquefaction-induced slope instability could occur have not been identified, but probably exist along the pipeline route in the Cascade Range and Northern Rocky Mountains.

Liquefaction that would not result in pipe rupture could cause it to float out of the ground. Impacts from such an event could include increased erosion, landslides, and damage to the pipe or auxiliary structures, requiring replacement of overstressed pipe sections.

Slope Instability. Slope instability presents a hazard to the pipeline system because slope failures could bend, remove support from, or rupture the pipeline and appurtenant structures. They could also block or damage access roads. Where the pipeline crosses known or suspected landslide areas, such as Brown Point, Partridge Point, or Siegel Creek, potential for significant or critical impacts would be high. In other areas of slope instability the potential impacts on the pipeline would range from low to high depending on bedrock competency. Bandera pump station would be located in an area of potentially critical impact from slope instability, (see Map Addendum).

Outburst Flooding. In areas where potential for outburst flooding is relatively high, scour and streambank erosion could be hazardous to the pipe. Such erosion could expose the line and pose a threat to pipe integrity. This possibility would be limited to the Cascade Range and Northern Rocky Mountains. There the pipeline would cross drainages that pass through areas of high topographic relief with potentially unstable slopes that could fail, block drainages upstream from the pipe, and cause outburst floods. In addition to scour and erosion, inundation of pump stations would be possible and could result in station shut down.

Abandonment Phase

Potential impacts resulting from seismicity, slope instability, and outburst flooding would be essentially the same under abandonment as during operation. However, their magnitudes would be lower since oil-contaminated wastewater would be spilled rather than oil.

Mineral Resources

Construction Phase

Implementation of the proposed pipeline would interfere with two active mines. A gold placer operation on Trail Creek (pipeline mile 432) would be forced to cease operation for the lifetime of the project. A copper-silver lode mine on St. Louis Creek (pipeline mile 507) would be forced to cease at least part of its operation for the lifetime of the project. Although both mines are very small with negligible contributions to regional and national gold, silver and copper production, cessation or reduction of operations could be a major impact to the mine owners. Until the precise location of the pipeline is determined, it cannot be known if the project would interfere with the development of other mineral deposits. These would include two active gold placer mines along Ninemile Creek (pipeline mile 508 to 515), and other known mineral resources such as aggregate (sand, gravel, etc.), subbituminous coal, silver, copper, and gold (see also section 2.1 Geology) as well as presently unidentified deposits. As portions of several antimony claims along Prospect Creek (pipeline mile 450) would be within the pipeline corridor, possible expansion of U.S. Antimony Corporation's Babbit mine onto these claims could be limited. If the operation of a mining claim is prohibited by the project, NTPC would be required (under the Mining Act of 1872) to make due compensation to the claimant.

There are no pending or active leases on the lignite coal deposits in eastern Montana and western North Dakota that would be crossed by the pipeline. However, it would cross lands in the Circle (Weldon-Timber Creek coal field) and Williston-Avoca KRCRAs (Known Recoverable Coal Resource Areas) and could prevent some extraction in these regions (Mowat, pers. comm. 1979). In addition, the pipeline would pass within 2 miles of the Circle West Project, a proposed open-pit coal mine and processing plant (liquid ammonia or liquid methanol) located within the Circle KRCRA. If the Circle West project is implemented and subsequently expanded, the pipeline could limit coal extraction operations. (See also section 3.2 Visual Resources and Map Addendum.)

Operation Phase

No impacts have been identified beyond those identified under construction.

Abandonment Phase

Abandonment of the pipeline system would release preempted land for mineral development.

Removal of the pipeline would involve considerable settlement within the trench. Between 1,700 and 1,900 cubic yards of fill material per mile would be required to complete restoration. Numerous borrow sites along the route would have to be located and utilized. Impacts from such borrowing operations cannot be assessed at this time.

SOILS

Soil alteration and disturbance along the pipeline route would occur from construction, operation, and abandonment. Environmental impacts from soil disturbance can be addressed in two categories: 1) those that affect the soil as a medium for plant growth, and 2) those that affect runoff, erosion, and resultant sediment yield. Impacts would result from the combined or single effects of precipitation, slope, existing vegetation, construction, and current land use. A reduction of soil productivity would be the end result of loss of protective vegetation, topsoil erosion, soil compaction, mixing of soil horizons, and contamination or dilution by fuel spills, pipeline leaks, and less fertile excavated material. Table 3.2-9 summarizes impacts on the soil.

Construction Phase

Construction operations would remove vegetative ground cover from the entire length and width of the pipeline right-of-way, 19 pump stations sites, a pressure reducing station site, 4 delivery facility sites, about 40 temporary pipe stockpile yards, and an undetermined number of miles of access roads.

Indirect impacts of loss of vegetation result from increased susceptibility to erosion or displacement. The degree of susceptibility would vary according to soil characteristics, topography, surface roughness, and presence or absence of protective soil cover such as vegetation, plant residues, gravel, cobble, or rock. The amount of erosion would be directly related to the time span between initial removal of vegetation and its reestablishment. An estimated 20,000 acres would be vulnerable to erosion at some point during construction. A reduction in soil productivity would occur with the loss of the more fertile topsoil (as compared with less fertile subsoil).

Soil series most susceptible to erosion or displacement are shown in Map Addendum and in the accompanying key to soil associations. Maximum impact would occur where alignment is down slope or in the direction of prevailing winds. Conditions conducive to severe erosion would also be adverse to revegetation. Effective revegetation would occur within 2 years on most terrain but would take several years in less favored areas.

Impacts of water erosion can be evaluated and quantified by the universal soil loss equation (Wischmeier and Smith 1972).

The equation can also be used to compare the effectiveness of various types of cover on the same soil and slope conditions.

TABLE 3.2-9 SUMMARY OF IMPACTS ON THE SOIL--PIPELINE ROUTE

Activity	Primary Impact	Secondary Impact	Possible Consequences
Earthwork (excavation, backfilling, levelings, maintenance, and dismantling)	Vegetation is removed	Water erosion is accelerated	Topsoil fertility is reduced
			Revegetation is impeded
			Stream sedimentation
		Wind erosion is accelerated	Topsoil fertility is reduced
			Revegetation is impeded
			Dust nuisance (people and plants)
			Visibility is reduced
		Leaching of soil nutrients is increased	Organic water content is reduced
			Soluble salts enter groundwater or streams
	Soil profile is altered	Mixing of topsoil with subsoil	Topsoil fertility is reduced
			Soil organic matter is relocated
			Revegetation is impeded
			Clay subsoils mixed with topsoils might decrease water intake rate
		Contamination or dilution with non-soil materials (rock debris, etc.)	Topsoil fertility is reduced
			Revegetation is impeded
		Subsidence or mass soil movement	Loss of soil productivity
			Plant cover is disturbed; erosion increased
			Soil contamination from pipeline rupture
		Normal plant-soil-moisture relationship is changed	Fertility is altered
			Rate of vegetation is altered
	Original ground surface configuration is disturbed	Runoff patterns are changed	Loss of productive capacity
			Revegetation is impeded
Prolonged stockpiling of topsoil	Soil biological activity is reduced	Productive capacity is altered	Revegetation is impeded Reduced crop yield
Erection of permanent structures (pump stations, delivery facilities, access roads)	Area of precipitation infiltration is decreased	Runoff is concentrated elsewhere	Soil erosion is accelerated
			Revegetation is impeded
			Stream sedimentation
	Soil is covered	Soil produces nothing	
		Soil is conserved	
		Soil is biologically inert	
Fluid leaks (construction, operation and abandonment)	Soil is contaminated	Existing vegetation is killed or stunted	Soil erosion is accelerated
			Revegetation is impeded
			Soil productivity is reduced
		Seed germination is hindered	Revegetation is impeded
		Reclaiming procedures might include additions of large amounts of chemical fertilizers	Contamination of groundwater or streams by leached soil solution
			Reclaimed soil might be more productive than before

It is not possible to quantify total soil loss other than in the general terms of tons per acre per year. All soil loss rates, as expressed in this discussion, are for soil surfaces void of vegetation unless stated otherwise. Much soil would be redeposited shortly after being dislodged from its original location and would never enter natural water courses. Soil loss includes soil displacement.

Annual erosion loss ratings in tons per acre have been arbitrarily assigned for low, medium, and high. These are 5, 5-45, and 45+, respectively. About 2,800 acres within the right-of-way would have a high potential for water erosion when ground surface is void of vegetation. Medium- and fine-textured soils on steep to very steep slopes are highly susceptible and occur mostly in the Pacific Border, Cascade Mountains, Columbia Plateau, and Northern Rocky Mountains physiographic regions. In the Pacific Border rates of water erosion would vary from 2 tons per acre per year on nearly level gravelly loam soils to more than 44 tons on steep silt loam soils. Similar rates would be expected in the Cascade Mountain region on steep slopes. Loessic soils and other fine-grained soils of the Columbia Plateau (pipeline mile 224 to 360) are highly susceptible to wind, rill, sheet, and gully erosion when disturbed. Soil losses as high as 50 to 70 tons per acre by water erosion have been measured on steep (30 to 40 percent) clean cultivated slopes for a single erosion season, and an overall average loss of 10 to 12 tons per acre per year for all cropland has been measured (Idaho-Washington RCD Project 1964). Predicted losses for silt loam soils with no protective cover and average annual precipitation of 16 inches are shown in table 3.2-10. It is assumed that similar losses would occur along the pipeline where vegetation was removed.

Erosion on steep slopes of the northern Rocky Mountains could result in 60 to 70 tons per acre per year loss of topsoil after construction. Site specific locations of erosion potential areas can be seen on maps in the Map Addendum.

TABLE 3.2-10 AVERAGE ANNUAL SOIL LOSSES BY WATER EROSION ON SILT LOAM SOILS IN LINCOLN COUNTY, WASHINGTON 1/

Slope Length (feet)	5 percent Slope (tons/acre)	10 Percent Slope (tons/acre)	20 Percent Slope (tons/acre)
200	6.1	11.8	40.8
500	8.0	20.3	53.0
1,000	10.2	25.5	62.2

1/ Based on SCS computations using Universal Soil Loss Equation where R = 16, K =.49; LS is variable, C = 1.0; and P = 1.3 (unpublished documents, Soil Conservation Service, Lincoln County, Washington 1978)

Losses from wind erosion would occur as fugitive dust emissions during actual construction activities and from strong wind action on unprotected soils after construction. Average losses from fugitive dust from clearing, excavation, backfilling, and grading would be 225 pounds per acre, depending on soil texture, soil moisture, and wind velocity. Loamy fine sands would lose 200 pounds of soil per mile from grading, 0.04 pounds per ton of soil from excavating, and 0.05 pounds per ton of soil from backfilling (SOHIO 1977). Losses would be about 25 percent greater on finer textured soils. Daily losses from fugitive dust are discussed in sections 3.1 and 3.2 Air Quality. These are average losses for pipeline segments during a typical day of construction. Table 3.2-11 shows typical fugitive dust emissions from vehicular traffic along a 5-mile-long construction site in the various physiographic provinces.

TABLE 3.2-11 EXPECTED FUGITIVE DUST EMISSIONS FROM VEHICULAR TRAFFIC FOR A 5-MILE SEGMENT

Physiographic Province	(tons/day)
Pacific Border	2.95
Columbia Plateau	4.40
Northern Rocky Mountains	4.35
Great Plains	4.80
Central Lowland	3.60

Source: SAI 1978

Fugitive dust losses from pump stations would be 0.3 tons per working day for each site, assuming 4.6 acres per site.

Actual pipe laying operations would be relatively short-term compared to the time soil surfaces would be void of vegetation. Total wind erosion losses would be influenced by the length of the time without vegetation. Arbitrary rate quantification for soil losses would be the same as for water erosion. Annual losses of up to 51 tons per acre could occur on exposed shaley subsoils of the Great Plains region if the pipeline were aligned with the dominant wind direction (USDI, Bureau of Land Management and the State of North Dakota 1978). Losses in excess of 20 tons per acre per year from single fields have been observed on rare occasions (USDA, EIS, Norman-Polk Watershed Project, Minnesota 1975). High potential erosion areas are in the Columbia Plateau, Great Plains, and Central Lowland physiographic provinces. Losses on highly susceptible soils without cover range from 45 to 200 tons per acre per year. Severe erosion is a common occurrence on summer fallowed wheatland in these areas and is indicative of what erosion rates could occur following pipeline construction. Actual rates could be less if the narrow pipeline right-of-way alignment was not on the steepest gradient. Calculations by SCS in Lincoln County, Washington, put annual wind erosion losses for unprotected silt loam soils at 15 tons per acre, assuming unprotected distances of 1,000 feet (unpublished document 1978). In Dawson County, Montana, winds of velocity sufficient to blow soil occur almost every month. Spring is usually the windiest time of the year and speeds average more than 20 miles per hour about 15 percent of the time.

Impacts from wind erosion would be less if vegetation or mulch cover were sufficient to afford adequate protection. The time span of potential losses would be 1 to 2 years in most areas and several years in those difficult to revegetate. Severe soil blowing could retard revegetation by damaging young seedlings.

Soil within the right-of-way would be compacted by normal traffic of construction vehicles and equipment. The effects of compaction on crop yields is well documented, yet there is not enough information available to measure quantitative or monetary yield losses. Compaction reduces soil pore space and retards water intake. Severe compaction can hinder seed germination, cause plants to emerge slowly, stunt vegetative growth, cause off-colored foliage, malform roots, and increase soil erosion.

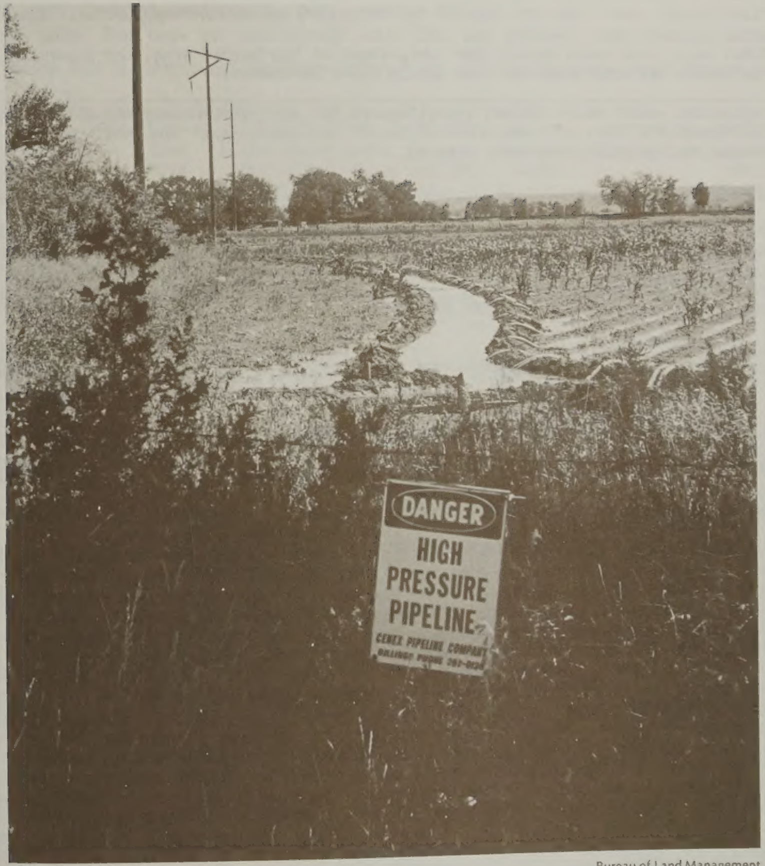
The degree of compaction would depend upon interacting factors of soil textures, moisture content, soil structure, pressure exerted by vehicle wheels, and the number of passes over the same area.

Compaction density increases with every pass over the same point. Soils most affected by pipeline construction would be seasonally wet areas of the Pacific Border and Central Lowland regions. Loss of soil productive capacity based upon estimates would be up to 20 percent the first year. Research indicates that productivity would be increased by plowing, freezing and thawing, shrinking and swelling, microbiological processes, and root growth within the compacted layer.

Mixing topsoil with relatively infertile subsoil would also reduce the productive potential. The rate of return to normal would depend upon reestablishment of the topsoil microorganism community and restoration of the chemical and physical properties of the disturbed soil. The potential for topsoil mixing or dilution would occur along the entire length of pipeline. Actual occurrence would be a fraction of the potential since landowners could stipulate that topsoils be put back in the original position in the profile. The total amount of soil mixing cannot be predicted. Stockpiling of topsoil would not completely do away with adverse impacts since even the most precise backfilling procedures would not eliminate all mixing. Deep heterogeneous profiles and shallow profiles would be most prone to adverse impacts. Deep homogeneous profiles would be least affected and would include the loessial soils of eastern Washington and western Idaho. An extreme impact would be a loss of as much as 25 percent of productive potential for the life of the project.

Assuming the average depth of the trench to be 8 feet and the average width to be 5.5 feet, approximately 8,600 cubic yards of material per mile would be excavated. Excess soil material displaced by the 40-inch pipe would be about 1,700 cubic yards per mile. The 42-inch pipe would displace 1,900 cubic yards per mile. The backfill would be compacted and mounded above the trench to reduce settling. Nevertheless, settling is a common occurrence and could be a potential cause of reductions in crop yields and the alteration of natural drainage patterns (Minnesota Department of Agriculture 1979). Excess material would be spread over the right-of-way or placed in an area agreed upon by the property owner and the applicant. Undesirable material such as rock fragments, stones, cobble, caliche, shale, and gravel is likely to remain on the surface. Amounts would depend on soil depths and parent material. Such materials could hinder revegetation. Soil productivity would be lowered according to amounts of nonsoil material left on the surface.

Soil could also be contaminated by refueling operations of motorized equipment and fuel storage facilities. Occurrence would be frequent but contamination would probably affect only a few square feet each time. The combined area of contamination



Productive agricultural lands in use over a pipeline

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would be less than an estimated 0.1 percent of the total right-of-way area. Plowing and revegetation activities would hasten biological degradation of oil particles to the extent that spill areas would return to normal within 2 to 5 years under favorable conditions.

Hydrostatic testing of the pipeline could result in impacts from erosion and would occur only in cases of unplanned releases or leaks of the test fluids. Such occurrences would be rare. Test water could leak from faulty weld joints and seams but would be confined to the pipe trench at most locations.

Soil erosion from test leaks would be less than 100 pounds per mile of line or less than 75 tons for the entire pipeline. Losses at specific locations would depend upon topography, soils, vegetation, size of rupture, and amount of fluid lost.

Operation Phase

Revegetation of unpaved areas would be complete or well underway by the second growing season after construction. Subsequent loss of protective cover and potential erosion would result from maintenance and repair activities and probably also from oil spills. Loss of vegetation from oil spills cannot be predicted with any degree of certainty. Most access roads would be surfaced, but an undetermined number of unsurfaced roads with continuing potential for erosion would be needed in remote areas.

Erosion losses would be normal after vegetation was fully reestablished. Assuming optimum conditions for vegetative cover, soil losses from water erosion would depend upon variable factors such as soils, slope, and precipitation. Greatest losses on noncropland would occur in steep mountainous areas where route alignment was downslope. Annual losses per acre would be as much as 7 tons on steep slopes where there was an 80 percent surface cover of mixed grass and broadleaf herbaceous plants and no tree canopy. Croplands could sustain losses of as much as 70 tons per acre on steep slopes and less than 1 ton per acre on nearly level slopes. Erosion from unsurfaced maintenance trails would range from 0.25 to 1.2 tons per mile per year.

Soil temperatures surrounding the pipe would vary according to oil temperatures within the line and cause some concern for crop growth variations and subsequent damages. Observations of other crude oil pipelines, however, do not substantiate these concerns. Oil in the pipeline along most of the route would normally be at temperatures at or near that of surrounding soils. Temperatures of oil at the port would be 80°F to 90°F. Mean annual soil temperatures in the Pacific Border range from 47°F to 59°F. Heat would dissipate through soils surrounding the pipe and should reach near ambient soil temperatures after traveling 50 to 100 miles from Green Point. The degree of heat dissipation would depend upon the soils' mineral content, texture, density, moisture, ground cover, and ambient temperature. Heat dissipation would result in slight changes in the microclimate immediately above the pipe inasmuch as the ground might remain unfrozen during winter months. Vegetative growth rate in the mountainous areas could be more than normal. Premature snowmelt, if it occurred, would be more gradual than normal spring snowmelt and would infiltrate the soil with little or no runoff. If runoff should occur it is expected that vegetation would prevent or retard abnormal soil loss.

Terrestrial oil spills would contaminate soils, reduce productivity, and increase susceptibility to erosion. Greatest impacts would be felt on prime agricultural land.

A leak too small to be detected by remote sensing equipment could amount to as much as 3,540 barrels per day, assuming a throughput of 709,000 barrels per day. Soil contamination from such a leak would continue until it was visually detected and stopped.

A spill of 1,100 barrels would have the potential to saturate about 1 acre of clay loam soil to a depth of 1 foot. This is based on average moisture holding capacity of clay loams at the wilting point and assumes that oil would fill pore spaces normally filled by water. The actual surface area and depth contaminated by a spill would depend upon the type of terrain and ground surface (MacKay and Mohtadi 1975).

It is incorrect to assume that the size of the spill area would be directly proportional to the spill volume. As volume increases, the net oil depth at the center of the spill becomes greater and the peripheral subsurface contaminated area becomes proportionally smaller (MacKay and Mohtadi 1975). Other research indicates that fine-grained soils retain more oil than coarse-grained soils. Penetration is deeper in sandy textures than in clay textures. Horizontal spread is greater on clay soils. It is evident that the area contaminated by a given size of spill would depend on soil characteristics, topography, vegetation, soil moisture, and oil viscosity. Loss of soil productivity would range from 5 to 10 percent at the fringes of the spill to 100 percent at points of saturation. Surface vegetation would be killed and movement of air and water below the surface would be inhibited. A further consequence would be the prevention of seed germination. Experiments in western Canada by Toogood and others showed that soils with as little as 2 percent oil by weight were affected for 5 or more years when no attempts were made to correct the damage. Plant growth is hindered by nutrient deficiencies, poor wetting conditions, and toxicity. Studies indicate that if an adequate nutrient supply is maintained plants will grow and mature in mineral soils containing as much as 10 percent or more oil by weight, and in peat containing as much oil as peat. The main problem appears to be one of nutrient deficiency rather than toxicity (Toogood and McGill 1977). Some other reclamation efforts have been less successful.

Studies by the Environmental Protection Agency indicate that soil micro-organisms recover rapidly from crude oil spills, become stimulated, and under the right conditions, help break down the oil (Environmental News 1978). Adverse effects gradually diminish as biological degradation of the crude oil progresses. Complete degradation depends on degree of saturation, temperature, oxygen concentration, microbial population, and nutrient supply. Evaporation of the volatile fraction and biological degradation are increased by hot, dry, sunny weather. Small concentrations of oil (less than 1 percent by weight) can disappear from subsoils quite rapidly. Experiments at the University of Alberta indicate that the application of commercial fertilizers to oil soaked soils will hasten biological degradation of the crude oil. Light spills (1-2.5 percent oil by weight) were reclaimed in 1 year with the addition of fertilizers. Medium spills (6 percent concentration) were reclaimed after 4 crop years. It was found that reclamation is faster when oil is spilled on wet as opposed to dry soil. It was determined that oil degradation is more rapid in a well-cultivated, fertile soil than in a soil low in organic matter and clay content (Toogood and McGill 1977).

Indirect impacts from oil spills occur from soil erosion as a result of loss of vegetation. Impacts would be similar to those previously described for soil erosion. Duration of impact would depend on time span between removal of contaminated vegetation and complete revegetation. This would be from 1 to many years.

Fires could cause indirect impacts by destroying protective vegetation, litter, and other ground cover leaving the soil more susceptible to wind and water erosion. Total soil loss would depend upon the extent of the burned area, the amount of cover destroyed, and the length of time ground cover is absent.

Explosions would cause minimal impact except for soil disturbance and displacement at the immediate area of explosion. Debris scattered upon the soil surface would reduce soil productivity until removed.

Abandonment Phase

Removal of the pipeline would cause a recurrence of those impacts described for the construction phase. Additional impacts would result from backfilling the trench. Extra fill material would be needed to close the void left by the pipe. Some soil would be contaminated by spillage of small amounts of residual oil left in the pipeline.

AQUATIC RESOURCES

Physical Components

This section discusses impacts to fresh water resources.

Construction Phase

Pipeline construction would affect surface water quality by increasing suspended sediment and turbidity during clearing, trenching, pipe installation, and backfilling operations. Sediment in runoff from the cleared right-of-way would reach surface water. The amount of sediment contributed would depend on intensity, duration, and frequency of rainfall, soil type, and the length and angle of the slope adjacent to the stream. At major stream crossings sediment from trenching activities would range from 2 to 6.5 cubic yards per foot of stream channel width, depending on trench depth and trench wall collapse. Suspended sediments would be carried varying distances downstream before they settled out, depending on stream velocity, slope, and size of sediment particles. Generally the smaller the particle the farther downstream it would be carried. As streams empty into reservoirs suspended sediments settle out. Useful life of those reservoirs could be shortened by reduced capacity. Sedimentation impacts could affect stream gradients. Impacts related to the modification of hydraulic characteristics would extend for a distance up- and downstream of the proposed crossings. Trench size, stream velocity, crossing width, streambed composition, and estimated increase in suspended sediment concentration from selected streams crossed by the proposed route are included in table 3.2-12.

Most streams would eventually flush themselves and return to preconstruction quality. Short-term increases in turbidity, suspended solids, and color would decrease light penetration and subsequently lessen photosynthetic activity. Potential organic load increases caused by streambed disturbance, such as resuspended decomposing organic material, could exert a higher oxygen demand and thus reduce the dissolved oxygen content of the water. Reoxygenation caused by turbulent river flow and the diffusion of atmospheric oxygen would eventually replenish the depleted dissolved oxygen. Dilution by inflow of cleaner water would decrease turbidity, color, and nutrient levels. Generally, impacts on water quality from construction would be short term, lasting less than 1 month.

TABLE 3.2-12 ESTIMATED SEDIMENT INCREASE OF SELECTED STREAMS--CONSTRUCTION 1/

Basin-Stream Crossing	Pipe-line Mile	Trench Size			Trench Volume (cu.yd)	Stream Discharge (cfs)	Streambed Composition	Sediment Increase (mg/l)
		Length (ft.)	Depth (ft.)	Width (ft.)				
Puget Sound Basin								
Dungeness	7	35	19	6.5	305	200	Gravel, cobbles boulders	1,300
Pilchuck Creek	64	NO DATA AVAILABLE						
N. Fork Still-aguamish	69	NO DATA AVAILABLE						
S. Fork Still-aguamish	70	NO DATA AVAILABLE						
Pilchuck River	86	NO DATA AVAILABLE						
Skykomish	97	NO DATA AVAILALBE						
Tolt	111	NO DATA AVAILABLE						
Snoqualmie	123	NO DATA AVAILABLE						
S. Fork Snoqualmie	134	70	20	6.5	682	150	Gravel, cobbles	3,100
Columbia River Basin								
Yakima	182	90	20	6.5	877	1 000	Cobbles, gravel	460
Columbia	224	2,550	47	6.5	93,500	61,400	Sand, gravel, cobbles	10
St. Joe	386	300	30	6.5	5,267	1,200	Sand	580
S. Fork Coeur d'Alene	414	35	14	6.5	197	250	Gravel, cobbles, sand	1,430
Clark Fork	464	625	25	6.5	8,264	10,000	Gravel, cobbles, sand	20
Clark Fork	470	600	20	6.5	5,644	5,000	Sand, gravel	110
Clark Fork	470	350	15	6.5	2,178	1,000	Gravel, cobbles	470
Clark Fork	471	500	13	6.5	2,667	1,000	Sand, gravel	540
Clark Fork	496	350	15	6.5	2,177	380	Gravel, cobble	120
Columbia River Basin (Cont.)								
Blackfoot	567	115	12	6.5	647	825	Gravel, cobble	560
Missouri River Basin								
Missouri	690	500	15	6.5	3,259	2,500	Sand, gravel, cobbles	220
Haymaker	764	3.5	11.5	6.5	15	20	Sand, gravel	17,050
Flatwillow Creek	843	12	14	6.5	57	20	Clay, silt, sand, gravel	29,000
Flatwillow Creek	848	12	14	6.5	57	30	Clay, silt, sand, gravel	19,500
Flatwillow Creek	870	60	16	6.5	407	50	Silt, sand gravel	11,250
Musselshell	874	125	17	6.5	926	130	Sand, gravel	4,100
Big Dry Creek	905	0	8	6.5	0	0	Clay, silt, sand	0
Big Dry Creek	940	40	21	6.5	404	30	Sand, gravel	17,850
Big Dry Creek	956	40	20	6.5	390	50	Sand, gravel	10,700
Redwater	1,015	40	17	6.5	296	25	Sand, gravel	14,300
Missouri	1,072	350	30	6.5	6,300	5,000	Sand, gravel	110
Little Muddy	1,100	15	12	6.5	72	20	Clay, silt	25,880
Souris-Red River Basins								
Souris	1,201	60	14	6.5	338	150	Clay, silt, sand gravel	6,000
Red	1,416	100	21	6.5	1,011	1,600	Silt, clay	630
Red Lake	1,422	85	18	6.5	658	1,200	Silt, sand	770
Red Lake	1,441	170	15	6.5	1,058	1,100	Sand, gravel	500

1/ Table includes streams requiring individual or general Section 404 permits under the discretionary authority of the U.S. Army Corps of Engineers, or requiring Section 10 permits.

The applicant proposes to backfill pipe trenches to avoid creating vertical ground water barriers. Ground water flow characteristics, therefore, would not be significantly affected by the construction of the pipeline, although some pipeline sections would lie below the water table. During construction, dewatering of the trench in seasonally shallow water table regions would be required. The displaced ground water could be pumped into adjacent drainages where it would recharge aquifers, or be mixed with other surface water without change in quality. Discussion of shallow ground water zones is included in section 2.1 Aquatic Resources, and these are identified in the Map Addendum.

The pipe would be hydrostatically tested for leaks. Test water would be withdrawn from streams along the route at a proposed rate of 6 cubic feet per second. If tests were conducted during periods other than low flow, up to 20 percent of the streamflow could be utilized. Testing during low flow periods could cause significant impacts. In some of the smaller streams most or all of the streamflow would be required. For test water with dissolved oxygen content greater than 13 milligrams per liter, sodium hydroxide could be added as a pipe corrosion preventative. The pH of the test water would be raised to 9.5. To avoid anerobic bacterial corrosion, a bacteriacide would be added to test waters remaining in the pipe for longer than 2 months. Raised pH and bacteriacide impacts could occur in test water discharge areas. Intensity of impact would depend on the dilution effect of the stream flow, background pH, and the volume and rate of hydrostatic test water discharged. Temperature of discharged test water would probably range from 50°F to 60°F. If temperatures for streams receiving test water were considerably higher or lower than the 50°F to 60°F range, a short-term, localized impact would result. Some oil could be introducted into discharge areas from the internal mandrel used to set the pipe, causing water quality degradation.

The discharge procedure for the test water could be a source of impact. If discharged under pressure into a stream, it could cause gouging, erosion, undercutting, or dispersion of bank and bottom sediments. Discharge into a treating pond and then to an existing waterway could create other impacts: percolation of hydrotest water from the holding pond could contaminate subsurface aquifers; or a leak in the impoundment would allow untreated water to flow over the landscape. If discharge of treated test water were released via siphon or low pressure pumping no significant impact would result.

No impact on groundwater is expected from hydrostatic testing unless a pipeline rupture occurs. Areas of seasonally shallow or perched water tables could be contaminated with treated test water. If no soda ash or bacteriacide were added to the test water, no water quality degradation would occur.

Operation Phase

Under normal operation, only minor impacts from maintenance are anticipated. Seasonal flooding would be expected in uncontrolled rivers. Major runoff events could expose the buried pipe and necessitate maintenance operations. Short-term sediment impacts would occur at the crossing and downstream. Impacts would be similar, although of less intensity and duration, than those during construction operations.

No direct impacts would result from fires or explosions. The most significant impact of pipeline operation would result from a pipeline rupture spilling oil into surface or ground water. There is a leak rate of 0.0022 leaks per mile per year (OIW 1978) for pipelines in the United States. Assuming about 5 miles of stream would be crossed by the pipeline, and a 20-year project life, 0.22 spills would be expected. This is equal to the possibility of a rupture-caused spill once every 91 years. Refer to section 3.2 Oil Spill, Fire, and Explosion Risk Analysis for a discussion of risk analysis.

Leaks of less than 0.5 percent of the pipeline capacity can not be identified by the automatic leak detection system. With a throughput volume of 933,000 barrels per day, leaks of up to 4,665 barrels per day (136 gpm) would go undetected until visually sighted by aerial line patrols, ground patrols, third party observers, or in-outmetering systems.

In the remote chance of a spill, the severity of impact on stream water would depend on the amount of oil spilled, chemical constituents of the oil, time before oil containment, topography of the area, types of stream bank and bottom sediments, volume of stream flow, and time of year. Stream banks and beds are vulnerable to toxic, low molecular weight crude oil fractions. Clay and silt substrates are particularly sensitive, having high oil absorbing properties. Potential for resuspension of bank stored oil exists. A long term adverse impact could result. Oil is dispersed at varying rates depending on stream characteristics. Slow silt and clay substrate streams would not have the dispersion impact downstream that fast gravel and cobble substrate streams would. Table 3.2-13 represents maximum potential oil spills based on block and check valve locations, length of crossing, shutdown and leak detection time (12 minutes), and volume of thoughput at all major stream crossings requiring special U.S. Army Corps of Engineers permits.

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Large trees along the right-of-way which may aid in reducing runoff sedimentation of streams would not be allowed to become reestablished. Hydraulic characteristics of the streams would return to preconstruction conditions in most cases.

TABLE 3.2-13 MAXIMUM POTENTIAL OIL SPILL FOR SELECTED STREAMS 1/

Basin-Stream Crossings	Estimated Length of Crossing (ft) Pipeline Mile	Valve to Valve	Throughput Volume-Barrels Per Day (bpd) 709,000 Min. Detected Spill (bbl)	Max. Spill (bbl)	933,000 Min. Detected Spill (bbl)	Max. Spill (bbl)
Puget Sound Basin						
Dungeness	7	560	950	6,830	960	8,700
Pilchuck Creek	64					
N. Fork Stillaguamish	69					
S. Fork Stillaguamish	70		NO DATA AVAILABLE			
Pilchuck River	86					
Skykomish	97					
Tolt	111					
Snoqualmie	123					
S. Fork Snoqualmie	134	840	1,420	7,920	1,430	9,160
Columbia River Basin						
Yakima	182	1,560	2,600	8,480	2,610	10,350
Columbia	224	3,800	6,300	12,180	6,310	14,050
St. Joe	386	1,920	3,200	9,080	3,210	10,950
S. Coeur d'Alene	414	480	820	6,700	830	8,570
Clark Fork	464	1,000	1,680	7,560	1,690	9,430
Clark Fork	470	1,720	2,870	8,750	2,880	10,620
Clark Fork	470	800	1,350	7,230	1,360	9,100
Clark Fork	471	1,000	1,680	7,560	1,690	9,430
Clark Fork	496	1,720	2,870	8,750	2,880	10,620
Blackfoot	567	560	590	6,470	600	6,340
Missouri River Basin						
Missouri	690	1,800	3,000	8,880	3,010	10,750
Haymaker	764	960	1,610	7,490	1,620	9,360
Flatwillow Creek	843	800	1,230	7,110	1,240	8,980
Flatwillow Creek	845	1,720	2,610	8,490	2,660	10,360
Flatwillow Creek	870	1,200	1,830	7,710	1,840	9,580
Musselshell	874	1,720	2,610	8,490	2,620	10,360
Big Dry Creek	905	440	690	6,570	700	8,440
Big Dry Creek	940	1,720	2,610	8,490	2,620	10,360
Big Dry Creek	956	2,200	3,330	9,210	3,340	11,080
Redwater	1,015	1,200	1,830	7,710	1,840	9,580
Missouri	1,072	920	1,410	7,290	1,420	9,160
Little Muddy	1,100	520	810	6,690	820	8,560

TABLE 3.2-13 MAXIMUM POTENTIAL OIL SPILL FOR SELECTED STREAMS 1/ (Cont'd)

Basin-Stream Crossings	Estimated Length of Crossing (ft) Pipeline Mile	Valve to Valve	Throughput Volume-Barrels Per Day (bpd) 709,000 bpd Min. Detected Spill (bbl)	Max. Spill (bbl)	933,000 bpd Min. Detected Spill (bbl)	Max. Spill (bbl)
Souris-Red River Basin						
Souris	1,201	1,200	1,830	7,710	1,840	5,580
Red	1,416	520	810	6,600	820	8,560
Red Lake	1,422	600	930	6,800	940	8,670
Red Lake	1,441	560	870	6,750	880	8,620

1/ Table includes major streams requiring Section 404 permits under discretionary authority of the U.S. Army Corps of Engineers, or requiring Section 10 permits.

Oil affects both physical and chemical properties of water. Generally, oil contains 70 to 100 percent CH_2 groups (isoparaffins, naphthalenes) and 0-30 percent CH groups (aromatics) (United Nations 1970). The lighter paraffin, cycloparaffin, and aromatic groups, up to 12 carbon atoms, usually evaporate in 24 hours; components with up to 16 carbon atoms usually evaporate within 10 days (Kreider 1971). Soluble and insoluble fractions will flow on the surface and below the oil slick at the same velocity and direction as the water. Most of the chemically toxic substances released in oil spills have been found to be the lighter low boiling fractions, the aromatic hydrocarbons, and the phenolic compounds (Snow and Scott 1975).

The major physical effect of oil on surface waters results from a surface film which reduces diffusion of atmospheric gases, primarily oxygen. Turbulence and wind action may reduce this effect. Since oil is absorbed by suspended matter such as clay, the effects of a spill may be carried for a long distance by these particles. Biological degradation of oil is a slow process and residual hydrocarbons have been reported in sediments many months after an oil spill (Schultz and Tebo 1975). Long-term effects on water quality would depend on the degradation process and the magnitude of the spill.

Changes in temperature, pH, dissolved solids, and biochemical oxygen demand would result from an oil spill. Temperature impact would vary depending on oil and water temperatures at the time of the spill. High water temperature and low oil temperature would probably induce a 1°F reduction in water temperature. The pH of rivers crossed is variable (tables 2.1-51, -55, -59, and -63), while oil pH is often around 5. An induced variation from a spill would probably reduce pH up to 1.5 units. Total dissolved solids (TDS) could increase by 100 to 1,500 milligrams per liter (mg/l) for the first 10 days following an oil spill. Five day biochemical oxygen demand (BOD), using the Streeter-Phelps equation for oil, was calculated at 2,380,000 mg/l (Streeter 1970). Over time, the BOD would be decreased by fresh water entrainment and would gradually approach the average BOD conditions before the spill (Fugro 1978).

Spill impact on ground water would depend on location and volume of oil spilled, water table depth below the ground surface, water table gradient, and permeability of subsurface materials.

As oil moves toward the ground water, some of the impurities (floating petroleum substances, suspended matter) are retained in the soil, while others may be degraded (phenols, mercaptans). Oil reaching the water table would "float" on the water because of its relatively low density. It would flow in the same direction as the groundwater although much more slowly because of the relatively large molecular size and high viscosity of crude oil. Some oil would adhere to subsurface materials. Oil would reach discharge areas such as springs, seeps, marshes, wells, or streams. Before being discharged in these areas, some of the oil would have been degraded naturally by plants and soil bacteria. Especially noxious are the dissolved petroleum substances which might seriously pollute the ground water layers (United Nations 1970). Areas of highest sensitivity would be the seasonally shallow water tables and potable supplies (map addendum, section IV). Oil spill impacts to ground water could last up to 10 or 20 years depending on the flushing capability of the aquifer, rate of decomposition of oil constituents by weathering and microorganisms, and sucessfulness of oil spill recovery.

Abandonment Phase

Abandonment procedures would require removal of oil from the pipeline and flushing with water to remove oil residue and combustible gases. A large quantity of water, 13.17 million barrels, would be withdrawn from the Columbia river. Impact on streamflow for the 3 week withdrawal period, would be insignificant, using less than 1 percent of the flow. Holding ponds would probably be required for separation of oil from waste waters before discharge into streams and rivers. Water infiltrating from holding ponds could contaminate ground waters, depending on the porosity of overlying strata and depth to ground water. Treated water would be discharged to rivers and streams. If discharged water was under pressure, gouging, erosion, undercutting, or dispersion of bank and bottom sediments would occur.

If the pipeline sections in streams and rivers were filled with a corrosion inhibitor and capped, iron compounds would be released by decomposition of the pipe. Streambanks and bed would subside as the pipe decomposed, modifying hydraulic characteristics of the stream. Decomposition impacts would be very slow and long-term, lasting decades after abandonment. No major change in stream quality would be anticipated.

Biological Components

Project caused impacts on fishery resources would result from two major sources: sedimentation of spawning areas, and oil spills. Sediment related impacts are discussed in the construction phase. Oil spills, including fuel oils spills, are discussed in the operation phase. Tables 3.2-14 and 3.2-15 summarize the impacts on fishery resources.

Construction Phase

Significant impacts would result from sedimentation of streambeds in spawning areas and in places where large concentrations of aquatic insects are produced. Sediments would originate from two sources: the streambank and the streambed. The removal of streamside vegetation during the construction phase would expose large areas of soil on the streambanks; these would be subject to erosion until revegetation occurred. Factors which would influence erosion include percent and length of slope, soil type and disturbance, amount of precipitation, and runoff patterns. Sediment would begin to enter the streams early in the construction phase (depending on runoff) as vegetation was removed and soil was disturbed. Instream trenching activities would cause downstream sedimentation as disturbances to the streambed occurred. Sediment arising from instream trench excavation would be most noticeable during the actual construction activity which would last several days in most cases. Factors influencing the distribution, and quantity of sediment downstream from the crossing would include bottom composition, water volumes and velocities, streambed slope, and excavation methods.

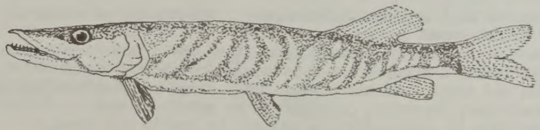
Most of the sediment would be deposited within a few hundred feet of the crossing area with the smaller particles traveling farther downstream (Crabtree, et al. 1978, Shapley, et al. 1965). Significant impacts should last 1 year or less since most of the sediment would probably be flushed out during the first period of high flows (Crabtree, et al. 1978; Shapley, et al. 1965; Saunders and Smith, 1965). This flushing action would be greater in streams with high flood flow velocities and high gradients. Sediment would continue to impact fish and insect populations as it moved downstream but the impacts would probably decrease because of sediment dispersal (Crabtree, et al. 1978).

Specific concentrations of aquatic insect production have not been identified, but their occurrence is likely immediately downstream from most crossings. These populations would be impacted by the sediments from streambank erosion and by those generated during instream trenching. Sediment related impacts on insect populations are well documented (Chapman 1962; Cordone and Kelley 1961; Tebo 1955). Sediment would reduce insect populations by: scouring the streambottom and dislodging insects, covering the streambottom and smothering the larvae and eggs, clogging the gills and suffocating the larvae, and by covering the stream bottom and preventing larvae from attaching themselves to rocks. Under the worst-case situation the entire production of these insects might be completely eliminated for several hundred feet downstream from the crossing for 1 year and reduced considerably for several years after construction if bank erosion and/or stream scouring continued. The most important insects impacted would be mayflies, caddisflies, and stoneflies. These insects occur mainly in Washington, Idaho, and western Montana streams and serve as the most important food source for juvenile salmon, and juvenile and adult trout. A reduction in the supply of these insects might retard fish growth and reduce survival. However, the impact would probably not be noticed since only small, local populations of fish would be affected and the reduced growth and survival rates would probably be within the normal range.

Sediment would mainly impact cold water fishes found in Washington, Idaho, and western Montana streams. These cold water fishes are identified in table 2.1-64. Many investigations have been conducted concerning the adverse effects of sediments on fish populations and findings are well documented (Burns 1970; Chapman 1962; Coble 1961; Cooper 1965; Cordone and Kelley 1961; Crabtree, et al. 1978; McNeil and Ahnell 1964; Saunders and Smith 1965; Shapely, et al. 1965; Sheridan and McNeil 1968). Most of the investigations deal with cold water fishes such as salmon and trout. Sediment deposition in spawning areas would settle in spawning gravels and fill in spaces, blocking water circulation to eggs deposited in the gravel. Sediment would also filter through the gravel and cover incubating eggs. Decreases in water circulation

TABLE 3.1-14 SUMMARY OF IMPORTANT IMPACTS ON FISHERY RESOURCES

FISHERY RESOURCE	IMPACT	CONSTRUCTION			OPERATION			ABANDONMENT			REMARKS
		Intensity	Duration	Magnitude	Intensity	Duration	Magnitude	Intensity	Duration	Magnitude	
Coldwater fishes: salmon and trout, both searun and resident. Found mainly in Washington, Idaho, and western Montana. See tables 2.1-64 and 2.1-65 for specific streams supporting these fishes.	SEDIMENT	Moderate at most stream crossings. Siltation from instream trench excavation.	1 year or less. Generally until high flows flush sediment from gravel.	Several hundred feet downstream from crossing.	Moderate at most stream crossings. Sediment influxes would occur during periods of runoff from streambank erosion.	For the project life but decreasing at most crossings throughout project life.	Several hundred feet downstream from crossing.	Low at most stream crossings. Siltation from streambank erosion Assumes pipe would remain under stream and minimal disturbances would occur to streambanks.	1 year or less. Generally until high flows flush sediment from gravel.	Several hundred feet downstream from crossing.	Siltation of spawning areas would reduce fish production if sediment is in gravel when spawning occurs or is deposited while eggs are incubating. Worst-case would eliminate all fish production for several hundred feet downstream from crossing for 1 year. Siltation would also reduce insect production. Fish losses would not generally be noticed except possibly in certain river fisheries in severe cases. Siltation would result from streambank erosion as vegetation is removed and soil disturbances occur and as instream trenching occurs during the construction phase. Siltation would decrease at most stream crossings throughout project life as revegetation occurs. Siltation would also occur during the abandonment phase if soil is disturbed. Some populations may remain suppressed after abandonment.
		FUEL OIL SPILL			PIPELINE RUPTURE			FUEL OIL SPILL			
All fish: cold and warm water species. Cold water fishes: salmon and trout, both searun and resident. Found mainly in Washington, Idaho and western Montana. Warm water fishes: bass, northern pike, catfish, walleye, etc. Finally mainly in eastern Montana, North Dakota, and Minnesota. See tables 2.1.64 and 2.1.65 for specific streams supporting these fishes.	OIL SPILL	Low in most cases because of small volumes.	Duration of the spill in streams. Up to several months in some lakes.	Several miles downstream from spill.	Moderate in most streams High in most lakes. High in most salmon streams	Impact would be for the duration of the spill. Several week residual impact in some streams Several month residual impact in lakes.	Several miles downstream from spill.	Low in most cases because of small volumes.	Duration of the spill in streams. Up to several months in some lakes.	Several miles downstream from spill.	Oil spills would reduce fish populations in all areas where high concentrations of oil occur. Worst-case could eliminate all fish which are exposed to oil. Fish would avoid oil concentrations where possible. Fish populations exposed to oil over a longer period of time would suffer higher mortalities. Potential impacts are greater in lakes which have low circulation and where fish are unable to avoid oil. Oil-contamination could enter the Tokal Creek Fish Hatchery and the Hurd Creek station downstream from the crossing area. All production in this facility at the time of exposure could be lost. Streams would clear rapidly but lakes may remain toxic for several months. Fish losses in lakes and streams would be noticed in severe cases. Full recovery of fish populations would occur after several spawning cycles. Fuel oil spills could occur during construction and abandonment phases from equipment operation. Pipeline rupture could occur during operation.



Northern Pike

TABLE 3.2-15 SUMMARY OF IMPACTS ON FISHERY RESOUCES IN WESTERN WASHINGTON STREAMS1/

Stream	Pipeline Mile	Construction	Operation			Abandonment
		Sediment Impacts	Oil Spill Impacts			Sediment Impacts
		Significant spawning Habitat2/	Hatchery Operations3/	Indian Fisheries4/	Juvenile Fish Populations5/	Streambank Erosion6/
Siebert Creek	1	No	--	Disrupted and reduced catches		Low
Dungeness River	7	Yes-4	High Contamination of Hurd Creek Station downstream.	Disrupted and reduced catches	High	Low
Pilchuck Creek	64	No	--	--	Low	Low
Armstrong Creek	68	No	--	--	Moderate	Low
North Fork Stillaguamish River	69	Yes-1	Moderate: Loss of exposed juveniles released upstream.	Disrupted and reduced catches	High	Low
South Fork Stillaguamish River	70	Yes-1	--	--	High	Low
Little Pilchuck Creek	82,84	No	--	--	Low	Low
Pilchuck River	86	Yes-7	--	--	High	Low
Skykomish River	97	Yes-2	Moderate: Loss of exposed juveniles released upstream.	--	High	Low
Cherry Creek	105	No	--	--	Low	Low
Harris Creek	108	No	--	--	Moderate	Low
Tolt River	111	Yes-5	--	--	High	Low
Griffin Creek	115	No	--	--	Moderate	Low
Tokul Creek	120	Yes-2	High Contamination of Hatchery Downstream. Moderate: Loss of exposed juveniles released downstream.	--	High	Low
Snoqualmie River	123	No	--	--	High	Low
South Fork Snoqualmie River	134	No	--	--	High	Low

1/ Refer to table 2.1-65 for more detailed information concerning spawning habitat, hatcheries, and Indian fisheries.

2/ Presence of significant spawning habitat for salmon and trout in crossing area. Number indicates miles of significant habitat downstream from crossing which would be subject to sedimentation from streambed disturbances during construction and streambank erosion during operation. An oil spill could also contaminate these areas.

3/ Estimated impact on fish populations associated with appropriate hatchery. Assumes large number of fish exposed to oil. Delay of migrating spawners could occur in all streams and could lead to decreased production.

4/ Estimated impact on Indian River fisheries. Disruption of fishing activities would occur during and immediately after an oil spill. Reduced catches would occur on subsequent spawning runs and during the current run if adult mortalities occur.

5/ Estimated loss of naturally produced salmon and trout (non-hatchery fish). Based on length of stream, number of fish likely to be exposed to oil, and significant habitat downstream. Impact would vary depending on season when spill occured.

6/ Distrubance to streambanks and resulting erosion is expected to be minimal to low in all cases.

to incubating eggs can cause mortality by suffocation through a reduced oxygen supply, and by preventing toxic respiratory by-products of the developing eggs from being washed away. Sediment deposition can also prevent newly hatched fry from emerging from the gravel and lead to poor quality and reduced survival of fry that do emerge. Deposition of sediment before spawning would have impacts similar to those previously described, since sediment is redistributed during the spawning process. If sedimentation were severe, 100 percent mortality could occur within the impacted area, which would generally extend several hundred feet downstream from the crossing. Most of the sediment would probably be flushed out of the gravel during the first period of high flows, with the remainder of the sediment moving downstream in subsequent years. Sediment would tend to settle in areas of low water velocities such as pools and lakes, and in estuarine areas.

Warm water fishes would also suffer these impacts, but to a much lesser degree since warm water fishes are generally adapted to waters with higher sediment loads than cold water fishes and spawn in areas with sediment covered bottoms.

Sediment which remained in the gravel for one year or less would only impact one year-class of fish. Since the different species of salmon and trout spawn at different times of the year and eggs can be found in the gravel during nearly all months of the year in most streams (figure 2.1-16), it would be possible to impact all species within a stream. Concentrated spawning for particular species normally extends for a considerable distance both upstream and downstream from the crossing area (several miles in some streams), the loss of fish in a relatively short stream segment should not have a critical effect on the population. In streams in which spawning habitat is limited to a few thousand yards or less, the loss to one year-class of fish within the impacted area could be significant and the overall stream population level for a particular species might fall below the normal range. Several spawning cycles might be required for these impacted populations to recover to previous levels. Only under certain circumstances such as a low number of spawning adults, severe sedimentaton, and loss of production in other areas of the stream, would the population be reduced substantially. Since some searun fish return to spawn every year and others every 2, 3, 4 or more years, up to 20 years may be required for some populations to fully recover. Pink salmon, which spawn predominantly every other year could be more noticeably reduced over a longer time than other species. Salmon and searun trout spawning areas are described in table 2.1-65 and shown in figure 2.1-15.

It is unlikely that any reduction would be noticed in the ocean commercial, sport, or Indian fisheries. However, if impacts are substantial, reductions might be detected in certain river sport and Indian fisheries, and in terminal fisheries in estuarine areas.

Fish populations in lakes should not be significantly impacted since sediments would settle out soon after reaching areas of slow water and little or no spawning for cold water fishes occurs in these areas. Sediment would also fill in pools. Fish using these pools as resting areas would be displaced. Increased competition with displaced fish should not have a significant impact on fish populations. Suspended sediment can clog and irritate the gills of fish and interfere with respiration. Severe conditions that might cause mortalities, particularily in juvenile fish, might extend downstream for several hundred yards. However, the number of fish expected to suffer mortality would be quite small, since fish would usually avoid such conditions. High turbidities could reduce the ability of sight feeders to capture prey.

Only the larger streams with major fishery resources have been identified in table 2.1-64, but smaller streams which support important fisheries would also be impacted during the construction phase. Many of these smaller, unidentified streams are important spawning areas, particularly tributaries of the Coeur d'Alene and Clark Fork Rivers, and streams in western Washington and western Montana. Sediment impacts to fish populations would be minor in streams containing little or no spawning habitat such as the Columbia River and lower portion of the Clark Fork River.

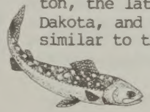
See section 3.2 Soils, for additional discussion of erosion, and table 3.2-12 for the estimated sediment increase in selected streams.

Minor impacts on fishery resources would result from riparian vegetation removal and test water withdrawal and discharge during the project construction phase. Removal of streamside vegetation would decrease escape and resting cover for fish (Crabtree, et al. 1978), decrease the quantity of terrestrial insects dropping into the stream as food items for fish (Chapman 1962), and increase water temperatures through shade reduction. The extent of these impacts would depend on the density and type of vegetation, the percentage of stream covered by the vegetation, and on the stream characteristics and fish habitat at specific sites. These impacts would last for the life of the project since only low shrubs would be allowed to become reestablished; they would generally be minor since only short stream segments would be affected.

Instream trenching activities would destroy undercut banks which serve as fish resting and hiding areas. As habitat is destroyed, fish would not be killed, but rather displaced to other areas within the stream, thus increasing competition with other fish. Both adult and juvenile fish would be impacted. This impact would last for the life of the project and would reduce the number of fish inhabiting the disturbed area. Fish numbers in undisturbed areas where competition was increased would tend to remain constant, thereby reducing the total number of fish within a stream.

Hydrostatic test water would be withdrawn and discharged at the end of the construction phase. Since intake screen sizes have not been identified by the applicant, it is not known what size fish would be excluded from the pipe. Fish passing through the screen and entrained in the system would suffer 100 percent mortality because of pressures generated in the pipe. Fish impinged against the screen could also suffer mortality. It is not expected that the number of fish impacted during testing would be significant. There should be no significant impact resulting from test water discharge since discharges would be in conformance with state or federal water quality standards thru NPDES permits. There should no be significant impact from a 0.5 percent reduction of base flow during water withdrawal.

Fuel oil spills associated with equipment operation near streams would probably be of short duration and volumes would probably be limited to a few gallons or less. Because of dilution and low volumes, minor impacts would be expected. Fishery resources in small lakes downstream from the spill area could be the most heavily impacted. Lakes of this nature include Bonnie Lake on Rock Creek in eastern Washington, the lateral lakes in the Coeur d'Alene area, Lake Irvine on Big Coulee in North Dakota, and other small unidentified lakes along the corridor. The impact would be similar to that for a pipe rupture described in the operation phase.



Operation Phase

The most important impact during the operation phase would result from a leak or pipe rupture. Such an event could occur at any stream crossing. The proposed leak detection system would be capable of sensing a .5 percent loss of throughput volume but would allow a leak under this limit to go undetected. A leak of up to 3,540 barrels per day at a throughput of 709,000 barrels, and up to 4,665 barrels per day at a 933,000 barrel per day throughput, could occur and would continue until detected visually and stopped. If oil were to spill, aquatic insect egg, larvae, and adult stages and both cold and warm water fish eggs, juvenile, and adult stages could be impacted. Sources describing the impacts of oil in freshwater environments are fewer than those concerning saltwater environments. However, studies indicate that oil has similar effects on organisms in the two environments, particularly coating and smothering and direct toxicity. References pertaining to oil effects on freshwater organisms in this section include: McCauley 1966; McKee and Wolf 1963; Morrow 1974; Murphy 1971; Pickering and Henderson 1966; Rice 1973; Rice et al. 1977; Rosenberg and Wiens 1976; and Wieber 1952. An oil spill could impact fishery resources in the following ways: 1) oil could act on the body and gill surfaces of fish and interfere with respiration; 2) oil could coat and destroy algae and other plankton; 3) settling oil substances could coat the lake or stream bottoms, destroying bottom organisms and interfering with spawning and feeding areas; 4) oil could be ingested by fish and taint the flavor of the flesh; 5) organic materials in oil could deoxygenate waters sufficiently to kill fish; 6) heavy coatings of oil on water surfaces could interfere with natural processes of reaeration and photosynthesis; and (7) in sufficient concentrations, some water soluble fractions could exert a toxic action on fish or fish-food organisms. Fish would probably attempt to avoid oil when possible. Avoidance behavior could interfere with spawning activities and reduce productivity. A fuel oil spill associated with equipment operation could have similar impacts.

Oil would probably spread downstream for several miles depending on streamflow characteristics and detection and shut-down times. The severity of impacts could range from the complete elimination of all fish and insects in lakes and for several miles downstream if exposure times and oil concentrations were high, to no detectable impact if spill volumes and oil concentrations were low. If elimination of a large percentage of fish occurred, several years would be required for the populations to recover to prespill levels.

Large oil spills could have major impacts on fish populations in small lakes and in such large lakes as Keechelus, Coeur d'Alene, Canyon Ferry, and Sakakawea, particularly if fish are unable to avoid high oil concentrations. Large spills could also have major impacts on the salmon fishery resource in western Washington streams, especially if large concentrations of juvenile salmon were eliminated. Since salmon spawn every 2, 3, or 4 years, depending on the species, the spawning run could be reduced for several years. Pink salmon, which spawn predominantly every other year, could be noticeably reduced for many years.

Oil-contaminated water would clear rapidly from streams, but could be retained in lakes and reservoirs for several months, depending on cleanup, circulation and retention time. Oil could adhere to stream and lake bottoms for several months or longer. Cleanup procedures and methods, including the use of chemicals, have not been identified. It is not known whether or not chemicals would be used or what the impacts to fish and insect populations would be if they were.

Concentrated populations of juvenile salmon released from hatcheries could also be seriously reduced if they were exposed to an oil spill as they migrate to the sea or as they spend time growing in streams before their migration. Fish released both upstream and downstream from the spill could be impacted. The Hurd Creek Station and Tokul Creek Fish Hatchery withdraw water downstream from the proposed crossing area for use in the hatchery facilities. If oil-contaminated water were allowed to enter these facilities, even in low concentrations, the entire production exposed to the oil could be eliminated. This would be a critical impact. Hatchery locations are shown in figure 2.1-15 and described in table 2.1-65.

Population reductions of salmon resulting from an oil spill would probably not be noticed in the ocean sport, commercial, or Indian fisheries. However, if impacts were severe, reductions could be noticed in certain river sport and Indian fisheries, and in terminal fisheries in estuarine areas. Population reductions in inland lakes could be noticed for several years if large numbers of fish were killed.

See table 3.2-13 for maximum oil spill potentials in selected streams, and section 3.2 Oil Spill, Fire, and Explosion Risk Analysis for additional information on oil spill risk.

Sediment related impacts initiated during the construction phase would continue to some degree during the operation phase. These impacts, specifically those associated with streambank erosion, would be most noticeable during the first few years of project operation. As vegetative cover becomes reestablished, erosion would decrease, thereby lessening the amount of sediment reaching streams. Impacts would be similar to those discussed in the construction phase. Sedimentation would generally decrease in most cases throughout the project life. However, specific unidentified sites could continue to be a source of sediment for many years if revegetation were not successful. Sites most likely to be a problem are those with steep slopes, unstable soils, and high runoff potential. Arid sites where revegetation would be sparse and slow could also pose a problem. Some crossings could continue to be problem areas throughout the project life as streambed scouring exposed the pipe. Streams likely to be a problem in this regard are meandering streams and streams with unstable bottoms and high flow velocities. Scouring would disturb sediment and carry it downstream. Sediments could also be resuspended and redistributed if it became necessary to operate equipment in streams to rebury the exposed pipe. Impacts would be similar to those described in the construction phase but would be of lesser magnitude since the disturbance would not be as great. There would be no direct impacts resulting from fires and/or explosions.

Abandonment Phase

Sedimentation from streambank erosion, as discussed in the operation phase, might again occur during the abandonment phase as vegetation was removed and soil was disturbed near streams. The extent of impacts would be less since the degree of vegetation removal and soil disturbance would be less. The loss to fishery resources would be minor in most cases.

A fuel oil spill could also occur if equipment were operated near streambanks. The chance of spills entering streams would be less than during the construction phase since equipment operation time would be less. Impacts would be the same as for oil spills described in the operation phase and would probably be minor since spills would be small and of short duration.

Physical Components

This section discusses impacts of the pipeline system to the salt water environment.

Construction Phase

Trenching for the submarine pipeline between Port Williams and Point Partridge would displace 488,000 to 553,000 cubic yards of sediment and glacial debris (NTPC 1979). The time required would be approximately 45 to 61 days. The suspended mud fraction (silts and clays) in sediments from Port Williams to north of McCurdy Point would degrade the water quality in the Strait of Juan de Fuca. Although no chemical analyses have been performed on these sediments, the suspended sediment could contain adsorbed components, such as heavy trace metals, chlorinated hydrocarbons, oils, greases, and phosphates which would have major impacts on water quality.

During construction, a turbid plume can be expected off Whidbey Island and westward into the Strait. Sequim Bay, Discovery Bay, and Admiralty Inlet would be particularly vulnerable to water quality degradation. Turbid conditions could persist for the time interval required to replace waters in the sand.

Similar degradation of water quality can be expected in the Whidbey Basin, particularly Skagit Bay and Saratoga Passage. Trenching between Polnell Point and Brown Point could require about 40 days; between 146,000 to 166,000 cubic yards of sediment would be displaced. The fine-grained marine sediments can be expected to contain high concentrations of pesticides and phosphates because of agricultural activities. Concentrations of these adsorbed components are not known. Below surface turbidity would also persist within Skagit Bay and Saratoga Passage, since flushing time for Whidbey Basin is long.

Operation Phase

Port Williams to Point Partridge

For trajectories of a hypothetical oil spill in March and September see Map Addendum. These trajectories do not include estuarine flow since little is known about this current in the eastern basin of the Strait of Juan de Fuca (Stewart 1978). Also, the trajectories are for submarine pipeline spills north of the currently proposed submarine pipeline corridor. However, the initial impact zones should not change appreciably. Initial oil landfall during March conditions would be San Juan Island from Deadman Bay to Eagle Cove; Lopez Island from Iceberg Point to Watmough Head; Protection, Smith, and Minor Islands; and the mainland from Rocky Point to Point Wilson, including all of Discovery Bay. During September conditions San Juan and Lopez Islands and Smith and Minor Islands would incur oil spill landfalls. However, the west coast of Whidbey Island from Point Partridge to Admiralty Head would be most likely to receive the first oil impact. Table 3.2-16 gives impact zones and nautical miles within the zones.

TABLE 3.2-16 PROBABLE IMPACT ZONES FOR PIPELINES FROM PORT WILLIAMS TO POINT PARTRIDGE

Conditions	Zone	Shoreline Nautical miles)
March	Deadman Bay to Eagle Cove (San Juan Island)	7
	Iceberg Point to Watmough Head (Lopez Island)	6
	Rocky Point to Point Wilson (Mainland), including Discovery Bay	27
	Protection Island	4
	Smith Island	0.8
	Minor Island	—
September	Deadman Bay to Eagle Cove (San Juan Island)	7
	Iceberg Point to Watmough Head (Lopez Island)	6
	Point Partridge to Admiralty Head (Whidbey Island)	6
	Smith Island	0.8
	Minor Island	—

Source: Stewart 1978; Oceanographic Institute of Washington 1978

After initial shoreline impact, currents could move the oil into the San Juan Archipelago including Rosario and Haro Straits, into Sequim Bay, into Admiralty Inlet, Hood Canal, and South Puget Sound, and onto Dungeness Spit, Vancouver Island's southern shoreline, and possibly its outer coastline. Such a spill would degrade marine water quality in the eastern basin of the Strait. Because of long flushing times in Hood Canal, Southern Puget Sound, and Sequim Bay, water quality degradation could be significant; the degree of impact would depend upon the size of the submarine pipeline oil spill.

Polnell Point to Point Brown

Oil spill trajectories and likely impact zones are not available for this area. Shorelines impacted by a spill could be Crescent Harbor, Oak Harbor, Penn Cove, the Rocky Point/Utsalady/Point Brown areas, and the shoreline and mud flats in Skagit Bay (see Map Addendum). Degraded water quality would persist for about 40 days. After initial landfall, the oil would be refloated on the flood tide, and on ebb tide transported down Saratoga Passage, up through Skagit Bay towards Deception Passage, and through the Swinomish Channel into Padilla Bay. Skagit River suspended sediments would also adsorb crude oil components. These sediments would aid incorporation of oil into bottom sediments (Baker, et al. 1978).

Abandonment Phase

Abandonment would have no impacts upon water quality in the Strait of Juan de Fuca, Sequim Bay, Discovery Bay, Admiralty Inlet, and Whidbey Basin since the submarine pipelines would be drained, internally cleaned, and capped.

Biological Components

Construction Phase

Anticipated impacts from the placement of pipelines would range from minor to negligible for biological resources near Protection Island/ Dallas Bank, Smith and Minor Islands, Whidbey Island, and in Admiralty Inlet. Anticipated impacts on biological resoures in Sequim Bay, Discovery Bay, Skagit Bay, and Saratoga Passage would range from moderate to major, and are discussed below.

Sequim Bay

Construction impacts are expected to be minor, for Pacific herring, capelin, mallard and pintail ducks, but could be moderate. The slow water exchange time in the bay, ensures that any contaminants entering the bay will remain for extended periods. Water quality degradation would have a minor to moderate impact on the intertidal and subtidal benthic organisms, such as the hardshell clam and geoduck clam beds. If chlorinated hydrocarbons and heavy trace metals were resuspended during construction, the clams could become unfit for human consumption.

Pacific oysters cultured here would also accumulate these contaminants. Results probably would not be fatal but could make the oysters unmarketable for months. The contaminants could be passed to other organisms in the food chain. Pacific herring breed in the bay and the success of their spawning could be diminished. Expected impacts would be moderate.

Discovery Bay

Because of similarities between Discovery and Sequim Bays construction related impacts would be similar. Construction impacts at Discovery Bay would be less severe because it has a more rapid flushing rate.

Skagit Bay

Skagit Bay is vulnerable to major impacts during the construction phases. Slow water exchange rates would prolong impacts. During construction of the pipeline large areas of fine sediment would be crossed, resulting in large sediment plumes. The resuspended sediments could have moderate impacts upon soft shell clam beds, hard shell clam beds, Pacific herring and surf smelt. Construction impacts to birds would probably be minor.

Saratoga Passage

Water exchange times are slow in this area. This factor would cause contaminants to be retained longer and would increase the severity of impacts. A major geoduck clam bed, and hard shell clam bed, as well as Pacific oyster culture and spawning areas in Holmes Harbor and Penn Cove occur here. Impacts on the species would range from moderate to major during the construction phase.

Operation Phase

Sequim Bay

A large oil spill could produce a major impact upon marshes and eel grass beds and organisms dependent upon those habitats. Moderate to major impacts on clams and oysters would also occur. The continued recontamination of clams from contaminated sediment would prolong these effects. Pacific herring would likewise suffer moderate to major impacts. If the spill occurred during a spawning period, effects would be aggravated. Anadromous fish using the Bay could be permanently displaced.

It is likely that the the impacts would be moderate to waterfowl although reductions in eelgrass could have serious implications to mallards. Since low level oil pollution causes decline in eelgrass, displacement of mallards could result. Other waterfowl species could be adversely impacted by reductions in eelgrass.

Discovery Bay

Anticipated impacts are major for rhinoceros auklet, glaucous winged gull, pigeon guillemot and pelagic cormorant.

Protection Island/Dallas Bank

Impacts would be moderate for harbor seals.

Impacts on kelp beds are expected to be minor. Hard shell clam beds would probably sustain moderate impacts. Impacts upon all resources would be lessened because waterflows around the bank would help remove and dilute the oil.

Admiralty Inlet

Major hard shell clam beds and geoduck clam beds, present in the Inlet, could sustain major impacts. Organisms dependent on clam beds would also suffer major impacts. Salt marshes, eelgrass beds, and their associated flora and fauna would be similarly impacted. Kelp bed impacts would be minor. Surf smelt and Pacific herring have critical habitat here. An oil spill in these areas during spawning season would have major impacts. Impacts at other times could vary from moderate to major. A spill could delay movement or temporarily displace anadromous fish using this area. Smolts, if present, would probably be killed. Overall effects would be minor. River otters could be impacted. Guillemots and canvasbacks could suffer major impacts. Surf scoters and rhinoceros auklet could be seriously impacted.

Whidbey Island

Eelgrass could sustain moderate to major impacts from an oil spill. An oil spill affecting the geoduck clam bed could cause a major impact.

Smith and Minor Islands

Kelp beds ringing these island would help keep oil off the islands. The kelp would sustain minor impacts themselves. The natural water movement around these islands would help remove oil in the case of a spill. The glaucous winged gull could suffer major impacts in the event of a spill, as could the rhinocerous auklet and guillemot.

Skagit Bay

Hard and soft shell clams, crabs, Pacific herring and smelt could sustain major impacts if a large spill occurred. Impacts would be worst if the spill coincided with spawning. Oil could destroy or displace anadromous fish resulting in moderate impacts. The extensive mud flats, salt marsh, and eelgrass beds and their associated organisms would be vulnerable to oiling. Oiling could have moderate impacts on the long billed dowitcher and western sandpiper. Damage to eelgrass beds could produce major impacts upon mallards and American widgeon. The whistling swan and snow goose are less vulnerable to impacts. River otters in the Skagit River would not be affected unless they entered the river mouth during a spill.

Saratoga Passage

A major geoduck clam bed, intertidal, and hard shell clam beds occur here, as well as Pacific oyster culture and spawning areas in Holmes Harbor and Penn Cove. All species could sustain mdoerate to major impacts during the operation phase. Surf smelt occur here as well as Pacific herring and could experience moderate to major impacts as a result of a large oil spill. Impacts to other fish species would probably be minor. River otters in Holmes Harbor could suffer major impacts.

Abandonment Phase

No significant impacts are anticipated if the submarine pipeline is drained of all oil, filled with inert material, and left in place.

Adult male otter

U.S. Fish and Wildlife Service

TERRESTRIAL VEGETATION

Construction Phase

The activities that will have a direct impact on vegetation are right-of-way clearing, construction or enlargement of access roads, main line stations and material stockpile yards, trenching, rock disposal, and backfilling and rehabilitation.

The primary impacts associated with these activities are loss of existing or potential renewable resources (timber, range vegetation) and potential loss of non-renewable resources such as threatened or endangered species, sensitive or unique plant communities, ecosystem diversity, and soil fertility and structure.

The loss of forests, range, and wetland vegetation is enumerated by county in table 3.2-17. A total of 3,934 acres of forests, 6,645 acres of range (grasslands), 300 acres of riparian woodland, and 393 acres of wetland would be disturbed by right-of-way construction. Forests and woodland would be lost for the life of the project on the maintained acreage. For the most part these plant communities would reestablish following project abandonment, except where irreversible changes occurred. The possibilities for such changes are discussed below, along with the general vegetative impact of construction.

Soil compression, berms left atop the pipeline trench, trenching, erosion control measures, and grading might alter existing drainage patterns on the surface or beneath the soil. Compression would hinder moisture penetration and decrease the water retention of the soil. Berms could create moist spots uphill from the trench while making areas downhill drier. Subsurface drainages might be intercepted by the pipeline trench and channeled away from their original directions of flow. Erosion control measures such as cross drainage channels could create new runoff patterns. Grading, would alter slopes and microtopography, thus changing runoff rates and moisture retention patterns. This would be especially true where the route crosses unfavorable topography such as narrow canyons and rocky, mountain slopes. Alterations of soil moisture patterns will effect adjacent vegetation.

Clearing of vegetation, and numerous related activities would increase erosion. This in turn would remove topsoil and perhaps topple vegetation in the eroded areas. In general, erosion would tend to decrease the productivity of the impacted areas, possibly altering the nature of future plant communities. Wherever forest land is newly cleared the adjacent vegetation would be exposed to the wind and would be more susceptible to damage. Windthrow and limb breakage may occur along right-of-way margins. This impact would be minimal where existing right-of-way is partly used. Deep forests of Douglas-fir and hemlock would be especially susceptible to wind damage since these species are shallow rooted and generally not wind-firm.

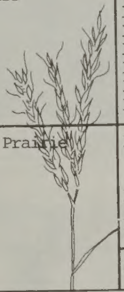
New clearing in deep forests may result in sunscald on adjacent trees formerly growing in deep shade and suddenly exposed to high light levels. This injury may weaken some trees in western Washington, Idaho, and western Montana.

Vegetation injured during blasting operations or heavy equipment, or weakened by exposure, loss of soil moisture, or contact with toxic chemicals would be generally more susceptible to invasion by insects, fungal infestations, and plant diseases. Vegetation already infected would suffer greater impact from parasites because of construction related stresses. Minor spills of toxic substances, such as fuels and

TABLE 3.2-17 ESTIMATED ACRES OF NATURAL VEGETATION AFFECTED BY THE PROPOSED PIPELINE

Ecoregion	Pipeline Mile	State/County	Construction (acres)				Operation (acres)				Average Bd.Ft./Acre Current Vol.	Average AUM/Acre
			Forestland	Grassland	Wetlands	Riparian	Forestland	Grassland	Wetlands	Riparian		
		WASHINGTON										
Cedar/Hemlock/Douglas-fir Forest	0-30	Clallam	28			10	21			7	14,000	
Willamette/Puget Forest	30-54	Island	88			8	66			6	14,000	
	54-103	Snohomish	411				308				23,000	
	103-126	King	265			6	200			5		
Silver fir/ Douglas fir Forest	126-144	King	226				168				10,000	
	144-180	Kittitas	559			24	419			18	10,000	
Sagebrush/Wheatgrass	180-224	Kittitas		353			400	265				
	224-274	Grant		378		23		284		17		
	274-312	Lincoln and Adams		187				140				
Palouse Grassland	312-360	Lincoln and Spokane		137				103				
Douglas fir Forest	360-367	Spokane	40				30					
		IDAHO										
	367-386	Benewah	102			4	76			3		0.5
Cedar/Hemlock/Douglas-fir Forest	386-410	Kootenai	189			2	142			2		
	410-443	Shoshone	337			23	253			17		
		MONTANA										
	443-505	Sanders	493	36		36	370	27		27		
	505-535	Missoula	303	12			227	9			9,000	0.25
Douglas fir Forest	535-580	Missoula	316	119		16	237	89		12		
	580-594	Granite	170				127					
	594-637	Powell	131	377		4	98	283		3		0.25
	637-669	Lewis and Clark	109	138		29	82	104		22		0.2
	669-670	Jefferson										
	670-714	Broadwater	73	265		15	55	199		11		
	714-740	Meagher	12	280		7	9	210		5		
Grama/Needlegrass Wheatgrass	740-757	Meagher		183				137				
	757-800	Wheatland		425		12		319		9		0.2

TABLE 3.2-17 ESTIMATED ACRES OF NATURAL VEGETATION AFFECTED BY THE PROPOSED PIPELINE

Ecoregion	Pipeline Mile	Construction (acres)					Operation (acres)				Average Bd. ft./Acre Current Vol.	Average AUM/Acre
		State/County	Forestland	Grassland	Wetlands	Riparian	Forestland	Grassland	Wetlands	Riparian		
	800-819	Golden Valley		204				153				0.1
	819-834	Musselshell		145				109				0.17
	834-836	Fergus		24				18				0.2
	836-874	Petroleum		393				295				0.25
	874-959	Garfield		926				694				0.2
	959-985	McCone		188				140				
Wheatgrass/Needle-grass	985-1014	McCone		199		4		150		3		0.22
	1014-1016	Dawson										
	1016-1072	Richland		366		5		275		4		0.19
	1072-1075	Roosevelt		22				16				0.16
		NORTH DAKOTA										
	1075-1135	Williams		263	2			197	2			0.5
	1135-1170	Mountrail		200	7			151	5			0.4
Wheat/Bluestem/ Needlegrass	1170-1177	Mountrail		42				31				
	1177-1219	Ward		78	24			58	18			0.6
	1219-1256	McHenry		233	58	16		175	44	12		0.5
	1256-1274	Pierce		124	12			93	9			0.5
	1274-1305	Benson		207	48			155	36			0.7
	1305-1346	Ramsey		107	93			80	70			1.0
	1346-1372	Nelson		28	53			21	40			
	1372-1390	Grand Forks			12	12			10	9		
Bluestem Prairie 	1390-1417	Grand Forks	42		21	28	32		16	21		
		MINNESOTA										
	1417-1471	Polk	25		36	12	19		27	9		
	1471-1484	Red Lake		6	12		0	5	9			
	1484-1492	Clearwater	15		15	4	11		11	3		
	TOTAL ACRES		3934	6645	393	300	2950	4985	297	225		

Sources for board feet: ERT 1978; Forest Service 1978; Average AUM/Acre: from Soil Conservation Service data.
Calculations based on 100-foot clearing for construction; 75-foot right-of-way used for determining maintenance acreage in all cases.

oils used during construction are likely to occur. Such spills would be confined to the right-of-way, but could temporarily deter revegetation.

In forested areas exposure of cleared land to increased sunlight would affect adjacent vegetation and influence revegetation on the right-of-way. Light-tolerant species would increase on and near the right-of-way, particulary grasses, herbs, and shrubs. Regeneration of shade tolerant trees such as hemlock would be inhibited until succession following abandonment led to development of seral forest. Eventually, succession on undisturbed, abandoned right-of-way would result in mature forests similar to those cleared during construction. The use of flammable materials, the operation of construction and incineration equipment, the use of fire for vegetative debris disposal, and the possible presence of careless cigarette smokers would all contribute to the fire hazard along the proposed route during construction. The right-of-way would have some beneficial impact on fire hazard since it would act as a firebreak, especially where the route follows ridgelines. The maintained right-of-way and construction roads may also improve access of fire-fighting equipment to remote areas.

Pipeline construction through rangeland would result in increased wind erosion and some soil losses while plant cover is absent. Rangelands would be susceptible to invasion by undesirable species following disturbance; medusa-head wild rye could invade cleared rangeland west of the Bitteroots, and cheatgrass (brome) the disturbed ranges as far east as central North Dakota. Both plants are very undesirable annuals, unpalatable to cattle and most wildlife. Cheatgrass invasion could cause severe problems in central and eastern Washington, Idaho, and Montana. Undesirable shrubs could also invade disturbed soils. Invasion of the right-of-way by these plants could be prevented by adequate revegetation with native, perennial grasses.

Construction through wetlands could result in their loss through alteration of surface or subsurface drainage. Since most wetlands along the corridor occur in depressions, pipeline construction would probably not affect surface drainage enough to eliminate them. In some cases trenching could pierce underlying impervious layers, leading to subsurface drainage and loss of wetland.

Clearing of right-of-way through forest would probably result in a temporary increase of plant diversity because of the resultant increase in shrubs and herbs. On the 3,251 acres of forest to be cleared and maintained, potential timber production would be lost for the life of the project. Accurate estimates of such losses are difficult to obtain because stands of widely varying quality would be crossed by a relatively narrow corridor. Estimated average production in board feet/acre is included in table 3.2-17 for counties where such figures are available.

Threatened and Endangered Plants

Any of the endangered or threatened species listed in table 2.1-67 could be adversely affected if construction activity caused elimination of local populations or even individuals. When plants occur only in small, localized populations, elimination of part of even one population can jeopardize the species' ability to survive.

Particular mention should be made of several plants which could be adversely impacted. Kittitas larkspur is known to occur in several places near pipeline mile 184 to 190. The route would apparently pass through a population of this plant. Few populations of this plant are known. Pauper milkvetch, known near pipeline mile 215, may be

White-tailed deer U.S. Fish and Wildlife Service

View of existing right-of-way through forested lands Bureau of Land Management endangered and could be impacted. Washington jacobs-ladder may be extinct, according to Hitcock and Crouquist (1976); however it might still occur in bottomlands in Spokane County, particulrly along Rock Creek.

Operation Phase

Normal operation and maintenance of the pipeline should have little adverse impact on vegetation outside the maintained right-of-way. Vegetation upon the right-of-way would be controlled by mowing, cutting, and/or herbicides. The use of herbicides could contaminate water and soil and subsequently enter food chains. Vehicular traffic on the pipeline right-of-way could also retard revegetation efforts by causing excessive soil compaction and creating areas subject to wind and water erosion.

Accidental oil spills could occur and cause substantial vegetative damage on and beyond the right-of-way. Oil replaces water in the soil and thus reduces the movement and availability of water to plants. Oil also has a herbicidal action which occurs when foliage is coated by it and its toxic properties kill the plant or reduce its viability (Hutchinson, Hellebust, and Telford 1974). Toxicity of oils is largely determined by the presence of aromatics and, to a lesser extent, by the presence of olefins, napthenes, and paraffins.

Direct effects of oil toxicity upon vegetation include loss of foliage, reductions in photosynthesis and nutrient reserves, reduced flower and seed production, and toxic effects on cells (Hutchinson, Arllebust, and Telford 1974). Defoliated plants would be less likely to survive natural environemntal stresses, such as harsh winters or drought (NTPC 1978).

As oil replaces water in the soil, less water is available to the plant and the oil-coated roots may physically reduce the plant's ability to absorb water. Microbial oxidation of oil components creates anaerobic conditions and further reduces the ability of roots to function (NTPC 1978). Because oil affects water absorbtion, plants growing in heavily oiled soils show signs of drought (Crummer 1964).

Indirect toxic effects and nutrient depletion could also occur. Toxic intermediates could be produced by bacterial activity on oil and be taken up by roots. Bacteria can also cause increased solubilities of trace elements. Iron and manganese can become toxic to plants under such conditions (Ellis and Adams 1961). Soil micro-organisms may increase in an oil-cantaminated area, deplete nutrients that are important to plant growth, and increase the availability of toxic trace elements (Harper 1939). Because growth and reproduction would be reduced, ground rhizomes and seed sources from outside the affected area would probabaly be needed for regeneration.

In temperate regions a spill of 0.1 to 0.9 gallons per square yard of soil will kill plants and require two to three years for revegetation. Plowing can free toxic voltiles and introduce oxygen, thus reducing regeneration time (Carr 1919); Schwendinger 1968). Emulsifiers used on a crude oil spill will probably increase toxic effects and inhibit plant regeneration (Cowell 1969; Smith 1968). Burning an oil spill on land also appears to inhibit plant regeneration by forming a blackened tarry surface (Hutchinson, Hellebust, and Telford 1974).

Regeneration of plants is best on well-drained soils. For many shrubs and trees there are few adverse effects if root systems are oil-free and well aerated. Summer appears to be the worst season for an oil spill because of the toxic effects of crude oil volatiles and because plants are growing. In winter, foliage is less likely to be covered and volatiles can escape before growth resumes. The key damaging factors appear to be foliage contact with oil toxics and oil replacing water adjacent to roots (NTPC 1978).

Oil from a small rupture below the threshold of the oil leak detection system would probably follow the less compacted material along the pipeline and surface at a stream or low area. Shallow rooted vegetation growing over the pipeline may die and cause once stabilized areas to erode.

A leak of about 60,000 barrels in a level area with moderately coarse soils low in loam and organic material could cover 40 to 50 acres and saturate the soils to a depth of 10 feet. Such a spill would kill all vegetation on the affected area, including trees, and would require several years to recover. The area affected by such a spill would be too extensive to replace with fresh soil.

The potential for the greatest adverse impact on vegetation would be in wetlands. Wetland vegetation is becoming increasingly uncommon but is a major community type in the prairie pothole region of North Dakota. The severity of a wetland spill would depend on its time of year and size. The undulating topography of the pothole region and the relative ease of visual detection should prevent the oil from spreading far, but affected wetlands would be extensively damaged, causing possible loss of rare plants and important habitat.

Fires and explosions would be potential occurrences at mainline stations. Should a fire or explosion occur, vegetation near the site could be destroyed.

Abandonment Phase

Impacts during abandonment would be similar to effects during construction.

TERRESTRIAL WILDLIFE

Introduction

Impacts on wildlife are of three basic types--habitat alteration, disturbance, and oil spills. Habitat alteration can result in either short- or long-term changes in the carrying capacity. Disturbance, particularly during the breeding season, can cause short-term population losses through increased mortality and decreased birthrates. The magnitude of disturbance impacts depends largely on construction timing. Figure 3.2-1 indicates periods of sensitivity to disturbance of selected species. Locations where significant impacts might occur are shown in the Map Addendum.

Oil spills can affect wildlife through toxicity and coating of fur or feathers, (see section 3.1 Marine Resources). Oil-spill impacts can be severe and last for many years.

Threatened and Endangered Species

Construction Phase

Impacts on northern bald eagles are summarized in table 3.2-18.

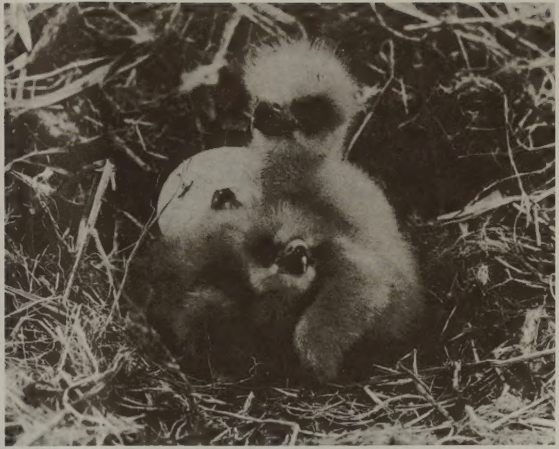
Disturbance along the proposed route would affect both wintering and nesting eagles. Impacts on wintering bald eagles would depend on: 1) the extent that vegetative buffer zones would obscure the line of sight; 2) the age structure of the eagle population; 3) activity in open regions plainly visible from eagle wintering grounds; 4) the proximity of eagle habitat to human activity; 5) the proximity of construction activities to open water and prey or scavenging resources; and 6) the increased vulnerability of winter habitat to harassment and predation. Disturbances could cause eagles to abandon wintering areas.

Impacts to nesting eagles are related to four essential components of nesting territories: 1) nesting trees in which the nests are built; 2) pilot trees which provide access to the nest; 3) perch trees for resting; and 4) fishing trees from which eagles forage for food. Destruction of any of these components could result in permanent abandonment of the territory. The proximity of the pipeline to nesting and wintering sites, the loss of habitat, and the timing and duration of construction activities would determine impacts on eagle populations. Identification of northern bald eagle nesting and wintering areas are presented in table 2.1-61.

No peregrine falcon nests have been located in the corridor, however, falcons have been sighted along the proposed route during the breeding season (see table 2.1-68). The peregrine falcon is extremely sensitive to disturbance during nesting activities (Snow 1972) and abandonment of active nest sites or historical nesting areas would prevent successful nesting. Relocation of displaced birds to other nest sites is unpredictable. Impacts are summarized in table 3.2-18.

Black-footed ferrets might inhabit prairie dog towns along the proposed route. Loss of part or all of a prairie dog town could reduce the ferret habitat and population.

The northern kit fox, Arctic peregrine falcon, whooping crane, and gray wolf would probably not be affected since these species utilize the corridor so infrequently



Eaglets

U.S. Fish and Wildlife Service

PERIODS OF SENSITIVITY TO DISTURBANCE OF SELECTED WILDLIFE SPECIES

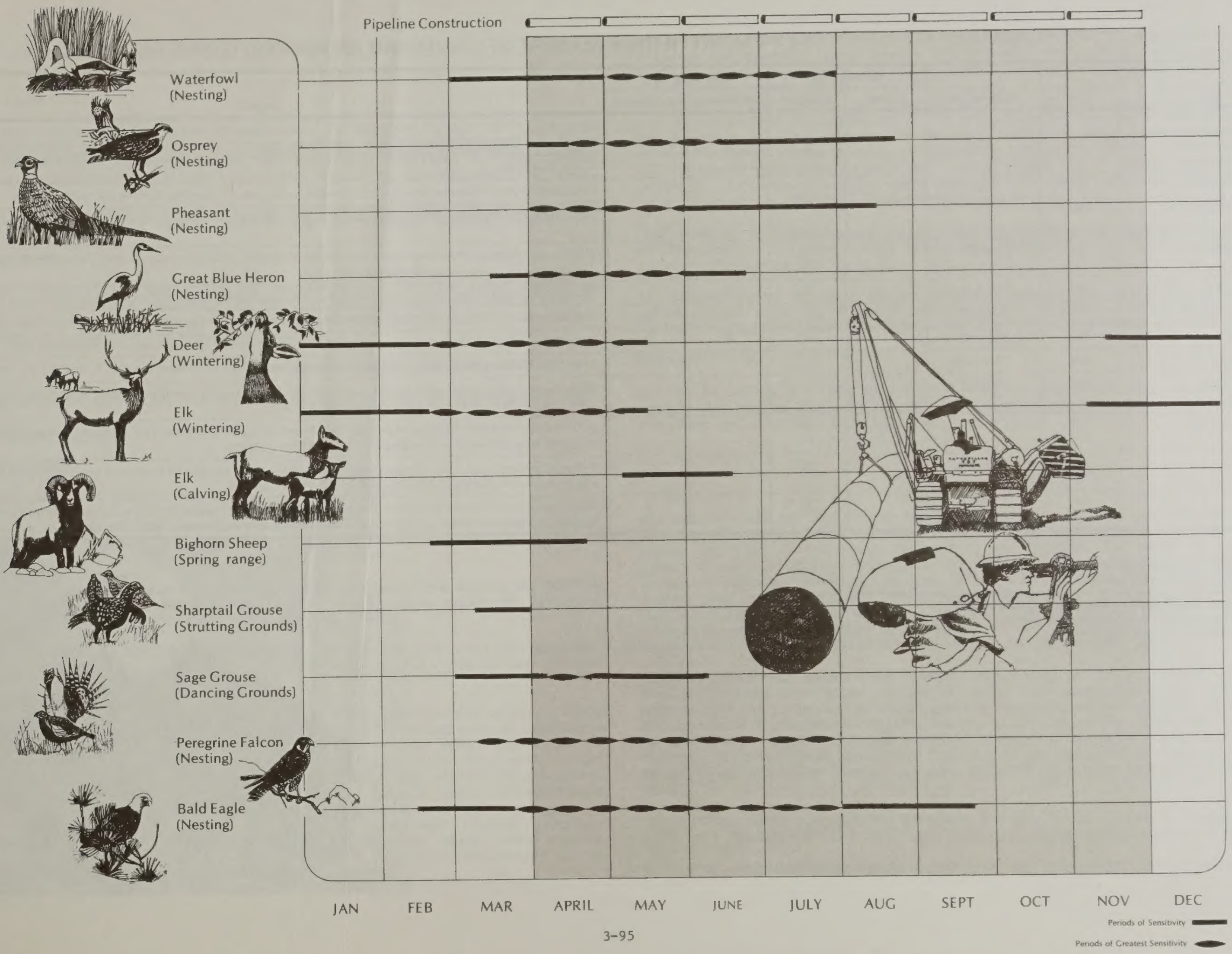


Figure 3.2-1

Table 3.2–18 SUMMARY OF IMPACTS ON NORTHERN BALD EAGLES AND AMERICAN PEREGRINE FALCONS[1]

Area	State	Pipeline Mile	Nesting Sites		Wintering Sites		Impacts
			Active[2]	Inactive[3]	Resident[4]	Occasional[5]	
Green Point	WA	0		X	X		Removal of winter habitat by destruction of roosts and disturbances of feeding areas would cause eagles to abandon the Green Point area.
Dungeness Bay	WA	10					Disturbance during construction may cause eagles to temporarily abandon feeding and roosting areas.
Dungeness Bay and Jamestown	WA	10				X	Disturbance during construction may cause peregrine falcons to temporarily abandon feeding and roosting areas.
Whidbey Island	WA	30-45	X				Disturbance during construction may cause eagles to abandon active nest sites near corridor. Other eagles feeding and roosting in area may temporarily abandon the area.
Keechelus Lake	WA	154-170		X	X		Potential nesting habitat may be abandoned and breeding eagles displaced to areas of less disturbance.
Couer d'Alene River	ID	380-425		X	X		Potential nesting habitat may be abandoned and breeding eagles displaced to areas of less disturbance.
Clark Fork River	MT	465-482		X	X		Potential nesting habitat may be abandoned and breeding eagles displaced to areas of less disturbance.
Ninemile Creek	MT	510-520					Disturbance during construction may prevent peregrine falcons from nesting in area.
Ninemile Creek	MT	500-530					Disturbance could cause eagles which may be present to temporarily abandon the area. Destruction of roosting trees which may exist would cause eagles to abandon the area.
Canyon Ferry River	MT	690		X	X		Potential nesting habitat may be abandoned and breeding eagles displaced to areas of less disturbance. Wintering eagles may be displaced and feeding and roosting habits altered.
Deep Creek	MT	695-700		X	X		Potential nesting habitat may be abandoned and breeding eagles displaced to areas of less disturbance. Wintering eagles may be displaced and feeding and roosting habits altered.
Pike Lake	MN	1485		X		X	Eagle nest destroyed but tree remains and may be disturbed causing abandonment of potentially productive site. Wintering eagles may be displaced from the area and feeding and roosting habits altered.

[1] See Table 2.1-61 for additional information.

[2] Nest occupied and young produced at least once a year.

[3] No known nests near corridor; potential nest sites available; observations of eagles in general area.

[4] Frequent observations of eagle populations from September through February.

[5] Occasional observations during winter; occurrence of resident populations unknown.

[6] Existing nest; production and occupancy unknown.

U.S. Fish and Wildlife Service

that the probability of encountering them or their habitats would be extremely remote.

Operation Phase

Northern bald eagles and peregrine falcons could be impacted by oil spills through feeding on tainted fish or waterfowl. Also feathers could become coated causing a loss of insulation. Wintering eagles are moderately sensitive to disturbance; right-of-way maintenance activities could cause eagles to abandon wintering areas.

Should an oil spill occur near a prairie dog town, contamination of potential black-footed ferret habitat with unknown direct and indirect impacts would occur.

Abandonment Phase

Impacts on northern bald eagles during abandonment activities would depend on timing of the disturbance, proximity of nests to the corridor, and sensitivity of individual eagles. Abandonment activities might stress wintering eagles and cause them to temporarily abandon the wintering site.

Impacts on peregrine falcons would be similar to those described under construction.

No impacts on black-footed ferrets would be expected during the abandonment phase.

Areas of Special Concern

Construction Phase

Table 3.2-19 describes impacts on wildlife in areas of special concern.

Several areas of high quality pheasant habitat would be lost. Corridor clearing in these areas would result in low, long-term population reductions. Minor short-term losses would occur as disturbances caused nest abandonment.

Ospreys in major nesting areas would be vulnerable to disturbance during the nesting season and abandon active nests. Construction could remove active or potential nesting snags, causing low, long-term population reductions.

Disturbance could cause short-term displacement of elk and deer from the corridor. Decreased riparian areas in drier prairies could result in reduction of deer populations.

Disturbances during the nesting season in wetland areas would have potentially major impacts on waterfowl. They cause nest abandonment and a resulting loss of production. Disturbance impacts would generally be low and short-term, except 247 miles of prairie pothole region between Missouri and Red Rivers. This area, with a high density of breeding waterfowl, could sustain moderate to high, short-term production losses from disturbance. An estimate of potential impacts could be derived by assuming: 1) loss of production within the 100-foot wide corridor and within an 1/8-mile strip to either side of the corridor; 2) an average breeding waterfowl density of 44.5 pairs per square mile (USFWS 1978); and 3) an average brood size of 8. Total production loss based on these assumptions, would be approximately 22,000 birds per year.

Prairie wetlands occurring at high elevations, where end moraines or dead-ice moraines are crossed, would receive the greatest construction impacts (North Dakota Fish and Wildlife Service 1978). Changes in wetland vegetative composition might alter nesting cover, visibility of nests and staging areas, easy access to water, stability of the pothole, and competition with grassland vegetation and associated grazing pressures. Recuperation of the vegetation may be greatly extended if cattle and wildlife use the corridor as an easy access to water. This could make the area less favorable as nesting or breeding habitat and have a short-term impact of decreasing waterfowl production. Construction could cause permanent wetland drainage. Any loss of wetland would represent a loss of waterfowl habitat and would be accompanied by a decline in waterfowl numbers.

Approximately 80 bighorn sheep in the Clark Fork River area (pipeline mile 529) would be disturbed. If construction activities occurred during lambing season, it is likely a portion of that crop might not survive.

An unknown number of sage grouse strutting grounds and sharptail grouse dancing grounds found along the proposed route would be disturbed. Activity in these areas during sensitive periods (fig. 3.2-1) could prevent reproduction.

Operation Phase

Oil could affect wildlife through toxicity or coating of fur or feathers, (see section 3.1 Marine Resources). Oil-spill impacts are adverse and could be of high magnitude and long-term duration.

Oil spills would be expected to have the greatest impact on wetlands and associated waterfowl. The magnitude of impacts to nesting or staging areas depends on the season and time of the spill, as well as the duration and amount of oil contact. Waterfowl are extremely susceptible to mortality from contact with oil. Common causes of death are drowning from loss of buoyancy, exposure from oil-coated feathers losing insulation properties, toxicity from ingested oil affecting kidney functions, and starvation from the inability to feed with oil-coated feathers (section 3.2 Marine Resources). Ospreys could suffer these same impacts, particularly those associated with oil ingestion through feeding on contaminated prey.

Wildlife requiring undisturbed habitat could move to other areas. However, if available niches are filled, mortality rather than displacement may occur. Tolerance to habitat manipulation varies greatly depending on the wildlife species. When the threshold for tolerance is low, alteration of vegetation, increased disturbance, or changes in competition and wildlife species in an area could have long term effects. If maintenance activities occurred during sensitive periods of the breeding season (i.e. nesting or display periods) wildlife production could be reduced for one year.

The corridor could also provide favorable habitat during the early stages of succession to a variety of wildlife. Deer and elk browse would increase in many areas.

A fire or explosion could cause mortalities and loss of habitat within a localized area.

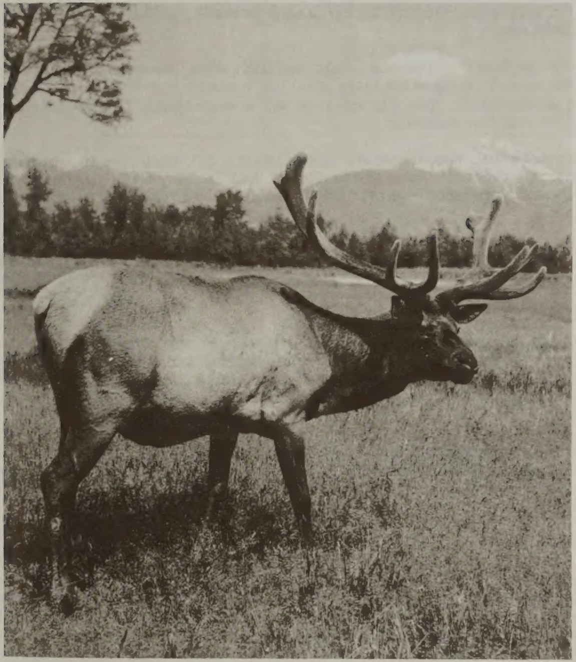
TABLE 3.2-19 POTENTIAL IMPACTS ON WILDLIFE IN AREAS OF SPECIAL CONCERN

IMPACTS											
			Construction		Operation				Abandonment		
					Normal		Worst-Case				
Area	State	Pipeline Mile	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term	Short Term	WILDLIFE IMPACTS
Pritchard Creek and Prospect Creek	MT	430-462	+L	-L	+L	-L	-L	-L	+L	-L	Vegetation removal would decrease available browse for elk winter range the first year and increase it thereafter.
			-H	-H	0	0	-H	-H	-M	-H	Destruction of beaver dams and reduction of beaver population.
Clark Fork River	MT	465-473	+L	-L	+L	-L	-L	-L	+L	-L	Vegetation removal would decrease available browse for elk winter range the first year and increase it thereafter.
		469-472	0	-M	0	-L	0	0	0	-M	Disturbance during spring could reduce productivity of the herd of up to 80 sheep.
		470	-L	-H	0	-H	-L	-L	0	-H	Disturbance of elk calving could result in stress on cows and calf mortality.
		470	0	-L	0	0	0	-L	0	-L	Destruction of habitat and disturbance could reduce production for 68 pair of geese.
		465-482	-L	-L	-L	-L	-L	-L	0	-L	Destruction of nesting habitat and disturbance during nesting would reduce osprey and raptor production.
Siegel Creek	MT	500-505	+L	-M	+L	-L	-L	-L	+L	-M	Reduction of deer and elk browse for one year and increase thereafter.
Ninemile Creek	MT	505-530	-L	-L	-L	-L	-L	-L	0	-L	Removal of old growth trees and increased disturbance could reduce owl and raptor populations.
			+L	-M	+L	-L	-L	-L	+L	-M	Reduction of browse used by white-tailed deer and 40-80 elk for at least one year and increase thereafter.
											Diminishing winter habitat available to big game along lower Nine-mile Creek would be further reduced.
Blackfoot River-Garnet Range	MT	554-605	+L	-M	+L	-L	-L	-L	+L	-M	Reduction of deer and elk browse for one year and increase thereafter.
			-L	-H	0	-H	-L	-L	0	-H	Disturbance during elk calving could reduce productivity.
			+L	-L	+L	-L	-L	-L	+L	-L	Reduction of grouse habitat for one year and increase thereafter.
Canyon Lake Ferry	MT	690	0	-L	0	0	0	-H	0	-L	An oil spill could impact up to 33,000 waterfowl.
			-L	-M	0	-L	0	-M	0	-L	Disturbance during nesting and destruction of nesting habitat could reduce waterfowl production.
			-L	-M	0	-L	0	-M	0	-L	Disturbance during nesting and destruction of nesting habitat could reduce waterfowl production and impact up to 800 Canadian geese.
Musselshell River	MT	740-770	0	0	0	0	0	-H	0	0	An oil spill could impact waterfowl production areas, as well as winter range for elk and deer.
Lake Mason	MT	825-830	0	0	0	0	0	-H	0	0	An oil spill could impact up to 11,000 waterfowl.
Flatwillow Creek	MT	839-849	-L	-L	-L	-L	-L	-L	0	-L	Disturb pheasant habitat and reduce pheasant production.
			-L	-L	0	-L	-L	-L	-L	-L	Removal of vegetation would reduce the carrying capacity of white-tailed deer range.
Fork Peck Lake	MT	964-976	-L	-M	0	0	0	-M	-L	-M	Disturbance may reduce availability of sagebrush and display sites for sage grouse. Prairie grasslands and communal dancing sites would be removed impacting sharp-tailed grouse. An oil spill could also impact grouse dancing grounds near tributary streams.
Williston, Stanley, Devil's Lake	ND	1090-1330	+L	-L	0	0	0	-M	+L	-L	Vegetation removal would disturb display sites for sharp-tailed grouse and reduce production for at least one year.
											An oil spill in nearby streams could also impact grouse.
Minot to East Grand Forks	ND	1207-1410	0	-M	0	0	0	-H	0	-M	An oil spill would impact prairie potholes damaging waterfowl habitat. Disturbance during nesting would reduce waterfowl production.
Red River to Clearbrook	MN	1415-1490	+L	-L	0	0	0	-M	+L	-L	Vegetation removal and disturbances could reduce populations of sharp-tailed grouse, greater prairie chickens, and pheasants.
			-M	-M	-L	-L	-L	-M	-L	-M	Reduction of winter habitat for deer.

Note: Construction, Operation, and Abandonment--assumes activities would occur during the most sensitive period for the species impacted (see figure 3.2-1) within the time frames indicated in figure 1.2-7.
Normal Operation: assumes right-of-way maintenance would occur every five years.
Worst-Case Operation: assumes a maximum oil spill event would occur.
Abandonment: assumes pipe would be removed.
Long-Term: lasting more than one year or affecting more than one generation.
Short-Term: lasting less than one year or affecting only one generation.
Significant Impacts: rated in magnitude as 0 (none), L (low), M (moderate), or H (high), and as + (beneficial) or - (adverse).

Abandonment Phase

Other wildlife would experience impacts similar to those described in the construction phase (see table 3.2-19).



Elk U.S. Fish and Wildlife Service

CULTURAL RESOURCES

Direct impacts would include displacement, damage, destruction, or burial of cultural materials by project actions. The potential for direct impacts to cultural resources would exist wherever construction activity would take place along the pipeline right-of-way: at access roads and utility corridors; at borrow, disposal, and pipe storage areas; and at pump station and delivery facility sites. Archaeological, architectural, historical, and paleontological resources are extremely sensitive to physical disturbance. In most cases, once disturbed, the damage is done and considerable value is lost. Indirect impacts to cultural resources would potentially occur as a result of the following circumstances:

Erosion and new weathering regimes which develop after clearing and construction.

Increased pedestrian and vehicular traffic over known and unknown sites as a result of newly opened access to previously remote and/or inaccessible areas.

Deliberate artifact collecting by nonprofessional collectors.

Inadvertent damage to sites by cars, trucks, and machinery operated outside the boundaries of the construction work area.

Alteration of the character of the setting of archaeologic or historic sites.

Intrusion of equipment and the pipeline itself across the traditional homelands of Native American populations.

Oil damage and physical disruption of archaeological sites on beaches by accidental oil spills and emergency clean up activities.

These indirect impacts could occur at cultural resource sites located outside the proposed pipeline construction right-of-way and even outside the 2-mile wide study corridor.

Archaeological and Historical Resources

Numerous sites are known to exist all along the proposed pipeline route. (The sites are listed in tables 2.1-71 and 2.1-72, and the general locations of the known sites are indicated on the Human Resources Alignment Sheets in the Map Addendum.) However, existing site inventory data and proposed project location and design feature information are presently not adequate for complete or accurate determinations of potential effects of the proposal. Site data are inadequate in two ways: 1) field inventories have not been carried out, therefore all existing sites have not yet been identified; and 2) the present condition and the significance of most known sites have not been evaluated. Therefore, the total resource base, its values, and whether or not sites will be directly or indirectly affected cannot be determined at this time.

On the basis of available information it is evident that there are virtually no areas of the proposed pipeline corridor in which the potential for discovery of presently unrecorded sites is known to be low or nonexistent. The only areas which can be excluded from this conclusion are steep slopes, mostly in the mountains. There are some areas in which the number and density of sites are likely to be low. Those are areas in which any sites discovered would probably be particularly important. This means that there is potential for impacts to cultural resources all along the pipeline route, including nearly all areas where no sites are presently recorded. This includes underwater areas which would be affected by the submarine pipeline, where there could be ship wrecks and former dry land sites now submerged by changing sea levels.

Construction Phase

Expected effects on archaeological and historical materials would occur primarily during the construction phase of the project. Unless the final pipeline route were carefully aligned to avoid known sites, they would be directly impacted. Even if direct impacts were avoided, some would receive indirect impacts. Direct and indirect impacts upon currently unknown cultural resources would be expected.

The potential for impacts from pipeline survey work would be relatively low and related to operation of vehicles and the limited clearing that would have to be done.

Right-of-way clearing would have a moderate potential for direct impacts on cultural sites in general, but could have high potential for impacts to surface and near surface archaeological sites. The intensity of impacts would in part depend upon the equipment and techniques used for clearing.

Grading, excavation, and trenching all have high potential for direct impact on cultural resource sites. Trench backfilling and right-of-way restoration would have relatively low potential for direct impacts, because any materials in the work areas would likely have been disturbed earlier by construction activities.

Erosion, vandalism, and traffic would be the primary potential causes of adverse indirect impacts during the various stages of the construction phase.

Operation Phase

The operation of the pipeline system would probably have no direct impacts on archaeological and historical resources. Indirect impacts might occur as a result of oil spills, and pump stations and cleared right-of-way segments might intrude visually on the settings of some sites. Archaeological sites partially affected by construction activities might be subjected to erosion or a new subsurface weathering regime which would adversely affect the sites' remaining values.

Abandonment Phase

The expected effects of project abandonment on cultural resources would depend upon how much excavation and pipe removal was to be done and on the adequacy of data recovery operations carried out to mitigate adverse effects of original construction. If mitigation projects were thorough and if excavation was confined to the original impact areas, the potential for additional impacts would be low. The potential for impacts would of course be high in any affected areas such as borrow pits, access roads, and pipe loading areas which were previously unsurveyed for archeological resources.

Paleontological Resources

Paleontological materials could be directly affected in all areas where the ground was disturbed by project activities. Fossils could be scattered, broken, buried, and destroyed. The values of the resource would be permanently lost. Deposits of fossils at or near the surface would be affected by grading, all forms of traffic, and at equipment and material storage areas. Subsurface fossils would be affected by pipeline trenching, excavations for foundations at pump station sites, and at borrow sites.

Indirect impacts would potentially occur as a result of collectors being attracted to newly exposed fossil deposits or to known deposits as a result of improved access. During the operation phase of the project, continuing indirect impacts from collecting, traffic, and erosion could be as serious as the direct impacts.

The expected effects on marine invertebrate fossils would generally, though not necessarily, be minor since the fossils tend to be fairly abundant in reasonably widespread deposits. Thus, pipeline trenching would probably affect only a small portion of the total resource.

The expected effects on vertebrate fossils could be much more serious. Vertebrate fossil deposits tend to occur in substantially smaller numbers and they are usually not widespread within a deposit. The disturbance of a vertebrate fossil locality could represent total loss of the resource.

Existing data on paleontological resources are not adequate for complete or accurate determination of potential effects. Even where fossil bearing deposits are known to be crossed by the proposed pipeline right-of-way, the depth of the formation below the surface is not known.

VISUAL RESOURCES

The BLM's visual contrast rating system was used to analyze the anticipated impacts. The form, line, color, and texture of each project element and any consequent alterations of the environment that it would cause were contrasted with the existing landforms and vegetation. Contrasts of moderate to high value in visually sensitive areas or those of high scenic quality were regarded as adverse visual impacts (table 3.2-20).

Because of the varied landscapes encountered, the route has been divided into 10 distinct segments for discussion of impacts. It is expected that impacts of the construction and abandonment phases would not differ sufficiently along the route to require separate treatment.

Construction Phase

Of the 433.5 proposed route miles in Washington, 174 miles would parallel or be within the Bonneville Power Administration (BPA) rights-of-way. The clearcut width of this corridor is over 600 feet in some areas and a width expansion is anticipated for upgrading or adding new powerlines. If no unmanageable conflicts between construction and operation of BPA's existing and future facilties exist, BPA will consider joint right-of-way occupancy.

TABLE 3.2-20 VISUAL IMPACTS ON VEGETATION PATTERNS

DEGREE OF CONTRAST WITH EXISTING CONDITIONS VIEWED IN FOREGROUND-MIDDLEGROUND

Degree of Contrast High = 3 Moderate = 2 Low = 1 None = 0		New Right-of-Way					Expansion of Existing Right-of-Way					Mainline Stations					Powerline Extensions					Block Valves at Major River Crossings				
	Weight Factor	Coniferous Forest	Ponderosa Woodland	Deciduous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Deciduous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Deciduous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Deciduous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Deciduous Forest	Grassland	Agricultural Land
Visual Contrast Elements	Form (wt. 4)	x2=8	x2=8	x2=8	x0=0	x0=0	x1=4	x1=4	x1=4	x0=0	x0=0	x3=12	x2=8	x2=8	x2=8	x1=4	x2=8	x2=8	x2=8	x0=0	x0=0	x2=8	x1=4	x2=8	x2=8	x2=8
	Line (wt. 3)	x2=6	x1=3	x1=3	x1=3	x0=0	x2=6	x1=3	x1=3	x1=3	x0=0	x2=6	x1=3	x2=6	x1=3	x1=3	x2=6	x1=3	x1=3	x1=3	x0=0	x2=6	x2=6	x3=9	x2=6	x1=3
	Color (wt. 2)	x2=4	x1=2	x1=2	x1=2	x0=0	x1=2	x1=2	x1=2	x1=2	x0=0	x3=6	x3=6	x3=6	x3=6	x2=4	x2=4	x1=2	x1=2	x1=2	x0=0	x2=4	x2=4	x3=6	x1=2	x2=4
	Texture (wt.1)	x2=2	x1=1	x1=1	x1=1	x0=0	x1=1	x0=0	x0=0	x0=0	x0=0	x3=3	x2=2	x2=2	x2=2	x1=1	x2=2	x1=1	x1=1	x1=1	x0=0	x2=2	x2=2	x1=1	x1=1	x1=1
Visual Contrast Rating		20	14	14	6	0	13	9	9	5	0	27	19	22	19	12	20	14	14	6	0	20	16	24	17	16

Maximum Allowable Contract Rating:		
	10 Class II	Project components should not be visually evident.
	16 Class III	Project should be subordinate to the landscape.
	20 Class IV	Project could be visually evident (could dominate landscape).

TABLE 3.2-20 VISUAL IMPACTS ON LANDFORMS

DEGREE OF CONTRAST WITH EXISTING CONDITIONS IN FOREGROUND-MIDDLEGROUND

Degree of Contrast High = 3 Moderate = 2 Low = 1 None = 0	Weight factor	New Right-of-Way			Expansion of Existing Right-of-Way			Mainline Stations			Powerline Extensions			Block Valves at Major River Crossings		
		Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slope Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less than 5 Percent)
Visual Contrast Elements	Form (wt. 1)	x2=8	x1=4	x0=0	x1=4	x0=0	x0=0	x3=12	x2=8	x1=4	x2=8	x1=4	x0=0	x3=12	x2=8	x1=4
	Line (wt. 2)	x2=6	x2=6	x1=3	x2=6	x1=3	x0=0	x3=9	x2=6	x1=3	x2=6	x2=6	x1=3	x2=6	x2=6	x2=6
	Color (wt. 3)	x2=4	x1=2	x1=2	x2=4	x1=2	x1=2	x3=6	x2=4	x1=2	x2=4	x1=2	x1=2	x3=6	x2=4	x2=4
	Texture (wt. 1)	x2=2	x1=1	x1=1	x2=2	x1=1	x1=1	x3=3	x2=2	x1=1	x2=2	x1=1	x1=1	x2=2	x1=1	x1=1
Visual Contrast Rating		20	13	6	16	6	3	30	20	10	20	13	6	26	19	15

Pipeline Right-Of-Way

Clearing of a pipeline right-of-way requires removal of existing vegetation and exposure of the soil causing an immediate adverse visual impact. A swath cut through dense forest on steep slopes would contrast sharply with a previously undisturbed environment. Even with subsequent revegetation there would be moderate color and texture contrast to the surrounding forest. Construction of the pipeline and access roads on steep slopes would change existing topographic features. Revegetation would be difficult, so the contrast of the exposed soil to the adjacent undisturbed vegetation could persist at least for the life of the project. In less scenic or more developed areas the contrast would be less noticeable.

Main Line Stations

A total of 21 main line stations, 20 pump stations and one pressure reducing station, would be located in all types of landscapes along the proposed route. A forested site was chosen for a worst-case discussion of visual impacts.

Land Form Modification. A 6 to 7 acre rectangular tract of land would be cleared and leveled. The color and texture of the exposed soil would contrast sharply if the station were sited in a dense coniferous forest.

Access Roads. The cuts and fills and surface of the road would also expose soil that would contrast in color and texture with the surrounding forest or other vegetative types.

Vegetation. Main line stations would be mostly devoid of vegetation and thus have high color and texture contrast with the dense forest cover of the surrounding environment.

Structures. Pump stations would contrast sharply with surrounding vegetative types. The linear form and color of the flattop tanks, square buildings, barbed-wire topped chain link fence, and the angular metallic ancillary gear, piping, and fittings would accentuate the contrast.

Support Facilities. Most main line stations would require a source of electric power and an electronic receiver for remote control that would be operated from the onshore storage faciity. In mountainous terrain, signal reflector dishes would be needed for microwave transmission; most sites would be on high, prominent points and most would require a road for construction and maintenance. Construction of access roads, powerline rights-of-way, and transmitter sites through forested land would accentuate the visual intrusion. The high color contrast of the exposed cut and fill embankments for the road and its prism would in most cases exceed the maximum allowable contrast for visual management class II and would cause severe adverse visual impacts.

In relatively flat, open field, seldom-seen areas, such as farmland, prairie, and grasslands, the contrast of a main line station or a delivery facility would be high. However, the site would usually be rated class III in the visual resource management system, because relatively few people would see it.

Operation Phase

The pipeline right-of-way through forest lands would cause moderate color and texture contrasts with the surrounding forest. This impact might continue indefinitely.

Major oil spills could cause adverse impacts to visual resources, especially shorelines, rivers, and tributary streams.

Contaminated water surfaces would adversely impact water color and quality. The resulting kill of fish and oil coating of vegetation lining the banks and shorelines would be another adverse visual impact.

Cleanup operations to contain, burn, or remove contaminated soil, rubble or vegetation would leave the shoreline or streambanks barren. Repair of a pipeline leak would require exposure of the subsoil and the pipe, with impacts similar to construction. Modifications in the natural form, line, color, and texture would persist for at least 2 years, and diminish over the life of the project.

In sensitive viewing areas, these visual impacts would be considered critical.

A fire or explosion could also cause adverse visual impact. The significance would depend on the location and size of the fire or explosion and the length of time necessary for vegetation to reestablish or structures to be repaired or removed.

Abandonment Phase

Impacts from removal of the pipeline would be similar to those for construction. Disturbance of hillside cuts and fills that had partially healed would cause new adverse visual impacts.

The removal of the pipeline in hilly country and on flat terrain would result in short-term visual impacts.

Abandonment of main line stations should lessen the high visual impact. However, in mountainous terrain, the cleared 6 to 7 acre site and access road to the remote control reflector site, plus the cleared right-of-way for the powerline would be easily discerned as color and texture differences. Even after considerable time, they would exist as a moderate to low adverse visual impact. Main line station sites should be undetectable after a short time period when located in a flat, open field area such as plains or prairie country.

Segment 1--The North Shore of the Olympic Sound to North Bend, Washington (pipeline mile 0 to 125.8)

Although the proposed pipeline would stay within, or parallel, existing rights-of-way wherever possible, it would occupy its own right-of-way over most of this segment. As described in the general remarks on construction, the clearing and alteration of the land for maintenance roads and installation of the pipeline would create contrasts that would cause adverse visual impacts in this highly scenic and visually sensitive segment. Construction would be in the view of motorists using Interstate Highway 5 near Stanwood and State Highway 2 near Snohomish. Severe adverse visual impacts would be realized during construction as the proposed route passed near towns, communities, and residences along the entire segment. Longterm effects of the cleared right-of-way in forested and populated areas, other than agricultural, would persist as a significant visual impact far beyond the life of the project. The 65-foot descent into the Strait of Juan de Fuca at Port Williams and the 35-foot ascent from the Strait at Partridge Point and the 80-foot ascent at Brown would require shallow cuts through the bluffs. Staging area would be on the flat agricultural land. These cuts through the bluffs would be in the foreground visual zones of boaters in the Strait of Juan de Fuca and Saratoga Passage. Therefore they would exceed maximum allowable contrast for visual management quality objective class II, and would be critical adverse visual impacts.

The visual contrast created by the crossing of Dungeness, North Fork Stillaguamish, Tolt, and Snoqualmie Rivers would exceed visual management quality objectives during construction. If revegetated properly the riparian landscape would soften the construction impacts, allowing the visual management quality objectives to be met within a few years after the construction phase. Pump stations number 2 (Arlington) and 3 (Carnation) would be located in an agricultural, seldom seen area and should not cause significant adverse visual impacts.

Segment 2--Cascades from North Bend to Yakima River (pipeline mile 125.8 to 181.5)

This segment is in visual management quality class II (USFS Retention) in which the proposed pipeline should not be visually evident. Portions of the segment would require new right-of-way through dense deciduous forest. This would be an undesirable visual contrast in a highly scenic and visually sensitive segment, and constitute a severe adverse visual impact to motorists on Interstate 90. Skiers, hikers, and other recreationists using Snoqualmie Pass ski area, the Pacific Crest National Scenic Trail, other hiking trails, Keechelus Lake, and Twin Falls State Park would all view the construction activities and the remaining scar for the life of the project and beyond. An overhead crossing of the Yakima main irrigation canal would be in full view of travelers on Interstate 90 and would constitute an adverse visual impact for the life of the project.

Pump station 4 (Bandera) would be located adjacent to a graveled service road across the South Fork of the Snoqualmie River from Interstate 90. Assuming that the thick forest between the river and the service road were not removed, only the top of the radio tower and possibly the upper portion of the pressure relief tank would be visible from the highway.

Both stations should meet the requirement of not being visually evident in the landscape and therefore satisfy established standards.

Other portions of the proposed pipeline route in this segment would require widening of an existing right-of-way. The visual impact would not exceed the visual quality objectives for class II.

Segment 3--Wenatchee (pipeline mile 181.5 to 223.7)

This segment would extend from the Yakima River to the Columbia River. It would be in visual management quality class III.

Although the proposed route would leave established corridors and take its own course through relatively featureless terrain, construction of the pipeline through the area would cause only moderate contrast, a visual impact that would persist as moderate to low for the life of the project.

The alteration of the Yakima River banks and the difficulty in reestablishing its riparian vegetation would result in linear forms and exposed soil color and texture persisting for the life of the project. This would create noticeable visual contrasts in this highly scenic, visually sensitive area and constitute an adverse visual impact.

U.S. Forest Service

Looking across Lake Keechelus

Source: ERT (Environmental Research and Technology)

Pump station 5 (Ellensburg) would be located in a seldom seen area.

Pressure reducing station 6 (Quincy) would be located in an open, treeless, uninhabited area. Although this station would contrast totally with its immediate environment, no adverse visual impact would be anticipated in this seldom seen location.

Segment 4--Columbia Plateau (pipeline mile 223.7 to 367)

This segment would extend from the Columbia River to the Idaho state line and be in visual management quality objective class III.

Grasslands and croplands should realize a moderate to low visual impact for the construction period, and low to none (after revegetation) for the life of the project. The proposed pipeline construction would meet the visual management quality objectives.

Pump stations 7 (Odessa) and 8 (Plaza) would be located in open, treeless uninhabited areas and contrast highly with the surrounding terrain. However, since this is a seldom seen region, the visual management quality objectives would be met and there would be no adverse visual impact.

The crossing of the Columbia River and Sprague Lake would require the removal of riparian vegetation, expose the banks, and have high visual impact for Sprague Lake and Crescent Bar recreation area residents and users during the construction period. An overhead crossing of the West Irrigation Canal near Ephrata would have a high visual impact when seen from State Highway 7 and a local road near the crossing. Riparian vegetation on both sides of the canal would be removed and the soil exposed during construction. With some return of vegetation, moderate contrast would persist for the life of the project, creating a minor adverse visual impact.

Segment 5--Northern Rocky Mountains (pipeline mile 367 to 608)

This segment would extend from the Washington-Idaho state line to approximately 5 miles southwest of Helmville, Montana. It is in visual management quality objective class III (USFS Partial Retention). In sections requiring new rights-of-way, the linear form and moderate color and texture contrasts would persist for the life of the project.

The upper reaches of Siegel and Ninemile Creek are very steep, forested slopes with rock out-cropping and narrow stream bottoms. A 90 foot or wider right-of-way cut through these pristine areas would result in extensive cuts, fills and exposure of subsoil and new rock as the trench was dug and access and construction roads are made. Even though a high degree of contrast would be introduced it would still be within visual management objectives.

As construction proceeds across the Clark Fork River to Bonner, some high visual impacts would be created for residents and travelers. This should persist as a moderate to low visual impact, proportionate to accomplished rehabilitation.

From Bonner the pipeline would occupy an existing railroad right-of-way for nine miles along the Blackfoot River. Although high adverse visual impact would be anticipated during construction, the operation phase should have low visual impact.

Overall the operation phase in this segment would maintain a moderate visual contrast rating persisting indefinitely as moderate to low, depending on the rate of rehabilitation. If the pipe is removed during abandonment, extensive physical damage could occur leaving the area scarred for an indefinite recovery period. This would create a significant adverse visual impact extending far beyond the life of the project.

Other sites that would exceed the maximum allowable contrast for visual management quality class II are:

> The pipeline and pump station number 10 (Enaville) would be visible to travelers on Interstate 90 and residents of Enaville.
>
> The new right-of-way the narrow and crowded valley of Prospect Creek would parallel several existing corridors and add to the visual contrast.
>
> The new right-of-way through forestland on the hillside opposite Thompson Falls would be in full view of the town's residents.
>
> Pump station number 11 (Paradise) would be visible from State Highway 200 and residents of Paradise.
>
> Significant visual impacts would be realized by travelers on Interstate 90 where the pipeline parallels or crosses the highway near Frenchtown, Milltown, Pine Grove, and West Riverside. Significant adverse impact would also occur along State Highway 200 near Bonner.

Segment 6--Eastern Portion of the Northern Rocky Mountains (pipeline mile 608 to 756.4)

This segment extends from 5 miles southeast of Helmville to the Meagher-Wheatland county line. It is in visual management quality class III. Most of the construction should cause moderate impacts, except for the crossings of the Blackfoot, Missouri, and South Fork of the Smith rivers. The clearing of riparian vegetation and the dust from heavy construction traffic at these crossings would be observed in the foreground by residents and recreationists. The residual scars would be in full view of travelers and recreationists for the life of the project.

The two pump stations (number 13 Elliston, 14 Townsend) in this segment should not present any significant adverse visual impact.

Segment 7--Missouri Breaks (pipeline mile 756.4 to 1100)

This segment would extend from the Meagher-Wheatland County line to Williston, North Dakota.

The construction through this relatively flat, sparsely treed segment would meet the visual quality objectives and not constitute an adverse visual impact. Pump station 15 (Harlowton) would be a part of the Glacier delivery facility situated in a remote and seldom seen area. It should not be a significant visual impact.

Pump station 16 (Jordon) would be in an open field, in the foreground and full view of travelers on State Highway 200. Visual contrast would be high--an adverse visual impact. Pump station 17 (Rickey) would be included in the Western Crude delivery facility and would not be a significant visual impact.

Typical pothole country in North Dakota

U.S. Fish and Wildlife Service

No major visual impacts are anticipated for the river and stream crossings in this segment. They would meet class III visual quality objectives and be subordinate to the landscape.

Segment 8--Pothole (pipeline mile 1100 to 1207)

This segment would extend from Williston to near Minot, North Dakota. The construction of a new pipeline through this open, flat country would have low impacts for the life of the project.

Pump station 18 (Tioga) would be a part of the AMOCO delivery facility in the Williston oil fields and would not cause significant adverse visual impact.

Visual quality objectives would be met in this segment and result in no adverse visual impact.

Segment 9--Plains (pipeline mile 1207 to 1441)

This segment would extend from near Minot to the Red River, North Dakota. The construction of a new right-of-way through this flat agricultural and grasslands region would probably be subordinate to the landscape and therefore meet class III visual management quality objectives.

Pump station 19 (Towner) would be in a somewhat remote, open field situated 5 miles west of Towner. In the same area the pipeline would parallel U.S. Highway 2 for 12 miles. Construction activities would exceed maximum allowable contrast for visual resource management class III. Some contrast would persist for the life of the project at a moderate to low rating, but not constitute a significant adverse visual impact.

Construction of pump station 20 (Devils Lake) would be in the foreground view of traffic on State Highway 20 and create a high visual impact and would persist as low to moderate until abandonment. Crookston pump station (number 21) would have a high visual impact on travelers along U.S. Highway 75 during construction, continuing as low for the life of the project. Maximum allowable contrast for visual resource management class III would be exceeded.

The crossing of the Souris River at pipeline mile 1,313, should present no visual impact for the life of the project and therefore meet the visual management quality objectives.

The Turtle River State Park at Arvilla, pipeline mile 1,392, is a heavily used summer and winter recreation area. The construction of the pipeline would require a 90-foot right-of-way through this northern flood-plain forest. It would be in the immediate foreground view of fisherman, tourists, and recreationists as the route skirted the park to the south. Color of the right-of-way would contrast with that of the forest when soil was exposed. This would exceed class III visual management quality objectives and constitute an adverse visual impact.

Segment 10--North Dakota (pipeline mile 1441 to 1490)

This segment would extend from the Red River in North Dakota to Clearbrook, Minnesota. The construction and maintenance of a new pipeline right-of-way through this flat agricultural land, with some scattered hardwood trees, would be subordinate to the landscape and meet class III visual quality objectives. The pipeline would not constitute an adverse visual impact. Additional tanks at the Clearbrook terminal should not cause any adverse visual impact.

LAND USE

The primary impact of the proposed pipeline and its ancillary facilities on land use would be the conversion of existing uses to the proposed project use for at least 20 years. Certain land uses including most cultivated crops and forage production can co-exist with the pipeline and associated uses. Other uses, such as timber production or intensive uses involving improvements, cannot coexist.

Certain project features preclude other uses. For the pipeline system, these would include pump stations, delivery facilities, remote block valves, electric substations, and communication sites. Additional land areas would be needed for such purposes as storage yards, borrow pits, and spoil disposal. An unknown amount of land would be needed for borrow and spoils disposal during construction. The estimated 40 storage yards, averaging about 12 acres each, would be located along railroad sidings or similar open areas. Utility lines, like the pipeline itself, would impact all types of land uses. Section 3.2 Transportation and Utility Networks, contains a listing of the electric transmission line right-of-way needed for the pipeline system.

Table 3.2-21, provides a summary of the types and amounts of land uses directly affected by construction of the pipeline system. The uses considered are those described in sections 2.1 and 2.2 Land Use; they are urban, agricultural (including pasture), rangeland, and forest. Other uses such as recreation, transportation, and mining are discussed under their respective headings in section 3.2. The acreages indicated in the following table and analysis assume an average right-of-way construction width of 100 feet, plus additional areas at major river, highway, and railroad crossings where conventional construction methods must be altered. These assumptions compensate for side hills where more than the minimum 90-foot construction width would be needed and make allowance for off right-of-way access road construction which cannot be estimated until a final alignment has been determined. It is also assumed that the life of the project would be 20 years after which pipeline facilities would be removed except for the pipe under major river, highway, and railroad crossings. It is uncertain whether the submarine pipeline beneath the Strait of Juan de Fuca would be removed or left in place.

Construction Phase

As indicated in table 3.1-54, construction would affect all types of land uses. The anticipated impacts are discussed in this section.

Urban

The pipeline would be constructed near urban fringe areas. In such districts construction would cause nuisance impacts of noise, dust, travel delays, and visual disharmony for brief periods that should not exceed 2 weeks in any one locale (assuming a 1/2 mile per day construction rate). These impacts are discussed in sections 3.2 Noise, Visual Resources, and Transportation and Utility Networks. Individually, these nuisance impacts might not be significant, however, in combination they might be so regarded at the locations shown on the alignment sheets.

Near urban fringe areas and in rural tracts where land has been subdivided for residential use, the pipeline easement would generally occupy a larger portion of land in individual ownership, and would often be considered incompatible with the owner's intended uses. In some instances the easement might make the land unsuitable for residental or other intensive use, depending upon the parcel size and local zoning restrictions. In the above mentioned areas this impact might be a cummulative one if the pipeline were part of an existing utility or transportation corridor. The existence of the pipeline easement, in itself, enhances the likelihood of additional adjoining easements for other facilities.

TABLE 3.2-21 ESTIMATED ACRES DIRECT IMPACTS OF CONSTRUCTION ON LAND USES

State	Urban Buildup	Agricultural	Rangeland/ Open Space	Forest/ Woodland	Other 1/	Storage Yards	Utility Service 2/	Total
Washington	32	1,401	1,056	1,617	343	168		
Idaho	12	252	0	628	29	60		
Montana	25	1,571	4,303	1,607	142	156		
North Dakota	30	2,403	1,281	42	388	96		
Minnesota	0	785	6	40	78	36		
Total	99	6,412	6,646	3,934	980	516	1,300	19,887 20,000 3/

Source: Aerial photo review and SCS reports

1/ Includes water, barren, and other areas as indicated in tables 2.1-5, 7, and 9.

2/ Due to recent route changes, utility service acreage impacted by construction is unknown at this time. Total utility service acreage should be approximately 1,300 acres, similiar to that of the original route alignment.

3/ Estimated

Agricultural

Construction would generally result in the loss of one year's crop on 6,412 acres, as indicated in table 3.2-21. This would amount to less than 0.1 percent of the agricultural land in each affected county. One year's crop loss could be expected since most crops raised within the corridor require a full growing season. Construction would take place from April through November progressing at a rate of about 1 mile per day. After construction, the soil disturbance and compaction might lessen productivity for a few years depending upon soil conditions, trenching method, and restoration measures. Crop losses would not be significant in terms of local (county) agricultural production, but would probably be considered so by some individual producers. Productivity might also be lessened by disturbances of irrigation and drainage systems. Subsurface drainage systems are particularly sensitive since they are difficult to replace properly once disturbed. There are subsurface drainage systems along the route in King County, the Columbia Basin of Washington, and possibly at other locations.

Construction of pump stations 7, 9, 11, 14, 20, and 21; of delivery facilities for the Western Crude Oil pipeline; and of numerous remote block valves would remove approximately 80 acres from agricultural production for the 20-year economic life of the project. Locations of these facilities are shown in the Map Addendum.

Some specialized agricultural uses are noise sensitive and might be adversely affected by construction activity. These include fur and turkey farms and apiaries. Several apiaries are located along the proposed route centerline in Minnesota. Noise impacts are discussed in section 3.1.

Approximately 3,900 acres with soils qualifying for designation as prime farmland are found within the proposed corridor, as indicated in table 2.1-76. Since these lands are, or could be highly productive, pipeline construction might cause a significant impact.

The potential impact to unique farmlands or those of state and local significance is not known as farmland designations have not yet been mapped.

Rangeland/Open Space

Pipeline construction would affect more rangeland than any other land use (table 3.2-21). However, this still represents an insignificant amount of the rangeland within each of the affected counties.

Construction activity would generally cause the loss of 1 year's forage from about 6,646 acres through its coincidence with the short growing season which lasts from about 100 to 150 days. Depending on soil and weather conditions, the trenching method, and restoration measures, productivity could be lessened for several years. Since rangeland is are not cultivated, productivity might be reduced for a longer period than with agricultural land. Rangeland could also revegetate with undesirable species less palatable to livestock. Section 3.2 Terrestrial Vegetation discusses such impacts.

The lands required for pump stations 2, 3, 5, 6, 8, 12, 13, 15, 16, 17, 18, 19; for the Glacier and AMOCO delivery facilities; and for numerous block valves, would remove approximately 155 acres from livestock grazing use for the life of the project (see Map Addendum).

Although losses in forage would probably not be significant, construction activity could be disruptive to livestock operations in other ways. Gates and fences left open could result in stock wandering or loss. Equipment operation and the pressure of an open trench could cause livestock injuries or fatalities. Removal of water from streams for hydrostatic testing or other disturbances to livestock watering systems could result in shortages of water.

Forest/Woodland

Construction would involve removal of all trees on the acreage shown in table 3.2-21. This volume would not be significant in relation to the annual timber production in each of the affected localities.

Within the permanent pipeline right-of-way, and at pump stations 1, 4, and 10 timber production would cease for the 20-year life of the project. The 3,934 acres affected do not represent a significant amount of available productive forest land within the counties concerned.

Construction impacts to forest land are also discussed in section 3.2 Terrestrial Vegetation.

Native American Areas

Pipeline construction across Puget Sound might adversely affect areas used by Native Americans for fishing. This potential impact is discussed in section 3.2 Aquatic Resources.

Construction would impact approximately 315 acres within the Coeur d'Alene Reservation in Idaho: 194 acres of agricultural land and 125 acres of forest and woodland.

Natural and Scientific Areas

Pipeline construction would probably not have any direct effects on most established natural or scientific areas. However, construction activity could impact the West Bar area (pipeline mile 223) which is being recommended for inclusion in the National Registry of Natural Landmarks. The area owned by the State of Washington and administrated by the State Game Department has geologic significance due to the formation of giant ripple marks formed during the Pleistocene age.

The proposed pipeline corridor is adjacent to a pristine vegetation area, the Antelope Range (mile 682), in Montana. The area could be impacted by construction activities.

Construction would cause a significant impact to the Oakville Prairie (mile 1,400) in Grand Forks County, North Dakota. This prairie is a relict vegetative area used for research by the University of North Dakota. Also, construction activity on relatively undisturbed areas would destroy their value for natural or scientific use. The likelihood of this occurring is unknown.

Wilderness

Construction would not cause any direct impact to established primitive or wilderness areas. The proposed pipeline corridor comes within five miles of six U.S. Forest Service and Bureau of Land Management designated wilderness study areas as indicated in section 2.1 Land Use. Pipeline construction would not affect continuing evaluation of the wilderness study areas.

Land Use Planning and Zoning

The proposed project could conflict with some provisions in County Shoreline Master Programs in Washington.

Construction across national forests over Snoqualamie Pass (pipeline mile 135 to 156) and within the Prospect Creek planning unit in Montana (pipeline mile 445 to 460) might not be consistent with existing Forest Service management objectives for these areas which require retention of visual resources and protection of water quality and fisheries. These same concerns, although not embodied in an existing plan, would also apply to national forest lands along Prichard Creek in Idaho (pipeline mile 416 to 443). The probable impacts of construction in these areas are described in the respective resource sections.

Operation Phase

As indicated in table 3.2-22, operation would involve significantly less land than construction. However, should large oil spills occur, additional land might be required for disposal of oily waste.

TABLE 3.2-22 LAND REQUIREMENTS DURING OPERATIONS (IN ACRES)

State	Urban Buildup	Agricultural	Rangeland/ Open Space	Forest/ Woodland	Other1/	Utility Service2/	Total
Washington	24	1,051	792	1,213	257		
Idaho	9	189	-	471	22		
Montana	19	1,178	3,227	1,205	106		
North Dakota	23	1,803	961	32	291		
Minnesota	0	589	5	30	58		
Total	75	4,810	4,985	2,951	734	1,300	15,0003/

1/ Includes water, barren and other areas as indicated in tables 2.1-67, 2.1-71, 2.1-73, and 2.1-75

2/ Due to recent route changes utility service acreage impacted by operation is unknown at this time. Total utility service acreage should be approximately 1,300 acres. similar to that of the original route alignment.

3/ Estimated

Urban

Pipeline operation should result in no significant impact to urban lands, in view of the secondary uses that could be made of the right-of-way, such as open space, greenbelt areas, recreation buffers, or utility corridors.

The potential impact of pipeline failure resulting in an oil spill, fire, or explosion would be more severe within urban areas than elsewhere, because of the more intensive surrounding uses and increased probability for loss of life. Since pipeline failures are most often caused by third parties, the likelihood of a failure could be higher in urban areas. However, lack of information precludes an accurate assessment of the increased failure risk inherent in urban environments.

Agricultural

Normal operation of the pipeline system should have few significant adverse impacts on existing agricultural land uses, except for those areas occupied by pump stations, delivery facilities, and block valves which would displace agricultural land uses. This would amount to a total of approximately 80 acres and does not represent a significant amount of agricultural land within any one locale.

In potentially irrigable agricultural land the pipeline would serve as a significant deterrent to irrigation, land leveling, and ditch construction. Land leveling for flood irrigation which requires cuts to depths of 4 or 5 feet would not be possible where the pipeline is buried with a 3-foot minimum cover. Pipeline routing would also influence the location of gravity irrigation (ditches and canals) and might preclude the watering of large areas remote from the pipeline right-of-way itself. Above ground facilities, such as block valves, could restrict the use of certain types of sprinkler systems like the center pivot type. Lands planned for irrigation in Washington are found in Grant, Lincoln, and Adams Counties (pipeline mile 230 to 425 and 270 to 287). Location of the pipeline through this area might decrease the amount of irrigable land. In lands planned for irrigation, pipeline routing is likely to cause a significant impact.

An oil spill occurring on agricultural land could ruin a portion of one year's crop and decrease productivity for 1 to 5 years following the spill, if reclamation was effective. The extent of such an impact would depend on the size and location of the spill, success of reclamation, time of year, soils, climate, and crop type. Alfalfa and rape seed appear to show the least tolerance to oil (Toogood 1977). Of these two, alfalfa is the only one commonly grown along the pipeline route. Oats and wheat reportedly show a good tolerance to oil residues while barley's tolerance is medium. Experience has shown that little reclamation occurs without tillage and application of fertilizer. Nonirrigated agricultural lands could prove more difficult to reclaim than irrigated croplands that are more likely to have soil moisture (see section 3.2 Soils). Some damage would probably occur during pipeline repair operations. If oil contaminated irrigation waters, crops might be damaged at locations beyond the pipeline right-of-way itself. This risk could be increased where overhead crossings of irrigation canals expose the pipeline to sabotage or vandalism. The anticipated frequency of a spill along the entire pipeline route on agricultural land is estimated at one spill in 0.8 year. It is likely that spills would occur on agricultural land during the life of the project.

Rangeland/Open Space

Pipeline system operation across rangelands should have few impacts except for those sites occupied by pump stations, delivery facilities, and block valves. These comprise approximately 155 acres of land on which forage production would be excluded for the life of the project.

Livestock operations could be adversely impacted in cases where access roads or the cleared right-of-way itself would result in undesirable patterns of forage utilization. Such an impact could be corrected by fencing. Conversely, access roads and the pipeline right-of-way might improve grazing patterns in some areas by improving livestock access to under utilized land. Except, in a unique circumstance, none of the impacts described above would be very significant.

An oil spill on rangelands would cause loss of forage within the affected area, and as with agricultural lands, the greatest losses would probably be caused by pipeline repair measures. The amount of land that could be significantly affected would depend on the size and location of the spill. The probability of an oil spill from the NTPC pipeline on rangelands is estimated at one every 0.7 years. Potential impacts to range vegetation are described in section 3.2 Terrestrial Vegetation.

Forest/Woodland

Pipeline operation would remove approximately 2,951 acres of forest and woodland from production for the life of the project. In addition, electric transmission lines serving the pump stations would remove additional forest and woodlands from production (table 3.2-22 contains an estimate of total utility right-of-way requirements). In terms of productive forest land within the affected areas, this impact would not be significant. Forest land could benefit from cleared right-of-way serving as a fire break or fire protection access. Realization of this possible advantage would be dependent on the right-of-way location. Conversely, the pipeline route could restrict the placement of forest management roads. Trees adjacent to cleared rights of way would be more susceptible to wind throw. Oil spill probability on forest lands for the entire pipeline route is estimated at one every 1.6 years.

Native American Areas

Normal operation and maintenance impacts on Native American lands would be similar to those described above.

Natural and Scientific Areas

Operation of the pipeline would not, under normal conditions, cause significant impacts to most existing natural and scientific lands. However, it might preclude the establishment of new areas. Operation would cause disturbance to relic vegetation on the Oakville Prairie in North Dakota, interfering with the University of North Dakota's research activities at this site.

Wilderness

Neither pipeline system operation nor an oil spill would be likely to impact wilderness resources.

Land-Use Plans and Zoning

In general, the pipeline system facilities would not seriously constrain land use plans and zoning since virtually all other types of uses could occur within reasonable proximity to its facilities.

Abandonment Phase

It is assumed that during abandonment the pipeline (except at waterway crossings), pump stations, and block valves would be removed. This would take approximately half as much time as construction.

Removal of the pipeline would require 1,700 to 1,900 cubic yards of fill material per mile. Numerous borrow sites would be needed. It is estimated that these sites would total about 175 to 225 acres.

Urban

Pipeline removal in urban tracts would create the same nuisance impacts as construction, but probably be more intensely felt due to urban growth near the line during the life of the project.

Agricultural

Removal of the pipeline would cause the loss of one year's crop on approximately the same acreage (6,412) as required for construction. Productivity might again be

Typical of forest lands in Cascade range in Washington U.S. Forest Service

Typical small urban center in North Dakota Bureau of Land Management

Rangelands U.S. Forest Service

reduced for several years. It is probable that the 80 acres utilized for pump stations and delivery facilities would not revert to agricultural use.

Rangeland/Open Space

Removal of the pipeline across rangelands would cause essentially the same impact as construction.

Forest/Woodland

Pipeline removal should not further impact forest lands significantly.

Native American Areas

Removal of the pipeline near or across Native American areas would cause essentially the same impacts as construction.

Natural and Scientific Areas

Pipeline removal would not cause any direct impact to most established natural or scientific areas. Abandonment would cause a significant impact to the Oakville Prairie site in North Dakota, by further disturbing relict vegetation.

Wilderness

Removal of the pipeline near wilderness resources would cause essentially the same impacts as construction.

TRANSPORTATION AND UTILITY NETWORKS

Inland Water Transportation

Construction Phase

Navigable waters are crossed at locations where there are significant levels of commercial vessel traffic. Vessel navigation could be affected during the laying of the pipeline across the Sound. Significant interference is not likely because there is adequate vessel maneuvering room. Recreation related boating activity might be impacted as indicated in section 3.2 Recreation.

Operation Phase

Normal operation of the pipeline system should cause no adverse impacts to inland water transportation.

A pipeline rupture in Admiralty Inlet or Saratoga Passage would require massive cleanup efforts, thus disrupting vessel traffic for at least one week.

Abandonment Phase

The process of abandoning the pipeline system should not cause any significant impact to commercial water transportation, although a potential impact might occur at the Columbia River crossing. If the pipe were left in place it might interfere with future plans to dredge a 14-foot channel from McNary to Wenatchee.

Railroads

Construction Phase

The possibility of adverse impacts to railroads would occur at the 60 crossings and along the 62 miles of shared or adjoining right-of-way. Since all railroad crossings would be tunneled, the impact to rail traffic should be limited to possible speed restrictions lasting for 1 week or less through the construction areas. Rail traffic slow downs might be of longer duration where construction is parallel to the railroad through areas confined by topography or other improvements. The Milwaukee railroad through Snoqualmie Pass, Washington, and the Burlington Northern at several small communities in North Dakota might be so impacted. The occurrence and extent of this impact cannot be determined until a final location for the pipeline is selected. It does not appear that such impacts would be significant.

Railroads would haul some of the construction materials. The estimated 40 storage yards would usually be located along railroad sidings where the pipe and other materials could be stockpiled. As railroads generally have excess capacity, transporting construction materials would probably not cause any adverse impact on rail service.

Right-of-way sharing could lessen the land use impact described in section 3.2 Land Use. The extent of this saving could not be determined until a final pipeline location was determined. Railroad right-of-way across private land is generally limited to 100 feet, of which a minimum of 45 feet is required for rails and ballast (for single track), thus leaving a maximum of about 27 feet on either side that might be shared. Other physical uses of the right-of-way extending beyond the tracks and ballast, such as parallel track, signals, and embankments, would diminish potential savings along the approximately 62 miles of proposed parallel right-of-way.

Operation Phase

An oil spill within a railroad right-of-way might cause impacts similar to those of construction. In extreme cases rail traffic could be temporarily delayed by cleanup operations.

Abandonment Phase

Assuming the pipeline were left in place at crossing no significant impacts would occur. Some delays to rail traffic might occur where pipeline removal operations were adjacent to the railroad right-of-way.

Road and Highway Networks

Construction Phase

Heavy truck traffic would probably cause some road damage near storage yards and pump stations. This impact is most likely to occur during the spring thaw period of April and May within Montana, North Dakota, and Minnesota, when roads are most susceptible to damage. Estimates indicate that approximately 1,200 tons of equipment and materials would be required to construct each pump station. For the pipeline, approximately 17,400 tons (based on 6 weeks pipeline spread requirements) of equipment and material, not including pad sand and spoils, might be transported over some roads and highways. Based on highway weight, width, and length limits within the five states, an estimated 165 special permits per pipeline spread might be needed (NTPC 1978). It appears, therefore that there would be potential for significant road damage. In mountainous areas many of the existing roads proposed for use would require substantial reconstruction to allow the transport of pipe in forty or eighty foot sections. Widening of some roads might also be necessay. For example, construction activity would effectively close the Siegel Creek road (pipeline mile 500 to 505), for a period of two weeks to one month.

Construction induced truck and commuter traffic might congest local roads near pump stations and pipeline sites for periods of up to one month. This impact, which could be locally significant, would proceed in a wave-like manner along each construction spread. It would be most severely felt near urban areas where high seasonal traffic and the lack of alternate routes already concentrate traffic. Maximum traffic volumes could reach about 1,000 vehicle trips per day, with about 500 occurring during peak commuter times. The daily traffic mix would be about 450 commuting workers and 50 truck deliveries.

Impacts could also occur where the pipeline crossed or was adjacent to roads and highways. The pipeline would intersect approximately 93 state and Federal highways and, 9 interstates. All these crossings would be bored (tunneled) as would local roads with high traffic volumes. Little or no traffic disruption should result. Unimproved roads and those of low traffic volume would be trenched, leaving one-half of the road open at a time. Such crossings could cause severe traffic delays during the construction period (typically 1 to 3 days), on secondary roads with high seasonal traffic. An improperly rebuilt roadbed could place undue stress on the buried pipeline. Construction alongside roads or highways would have the most impact in mountainous areas where alternative travel routes where unavailable and in urban fringes where traffic densities were high. Locations susceptible to these impacts are shown in the Map Addendum. Permanent access roads to pump stations would generally require less than one mile of new construction, except the road to the Glacier delivery facility in Wheatland County, Montana, which would require as much as 3 miles of new construction. The construction of new permanent access roads would probably not significantly affect any area.

Temporary access roads would be needed in mountainous areas and at intersections with deeply incised drainages where pipe stringing trucks (and perhaps other equipment) would not be able to follow the right-of-way. These roads would generally be less than one mile in length and would not significantly impact road and highway networks.

Right-of-way sharing might lessen the land use impacts described in section 3.2 Land Use. The extent of this possible saving cannot be determined.

Operation Phase

Normal operation should not result in any significant impacts to roads and highways. However, future road grade changes could be restricted due to the placement of the pipeline. Additional traffic generated by pipeline system operation would be minimal, except in the case of a major oil spill. Cleanup efforts could generate intensive traffic on local roads and highways near the spill site lasting for a few days to a week.

An oil spill near a road or highway would require pipeline repair which might disrupt traffic for a time in essentially the same manner as construction.

Abandonment Phase

Removal of the pipeline could cause impacts similar to construction but of less magnitude, since it is assumed that not all materials would be removed. Salvage would take less time than construction, but would probably affect roads and highways with larger traffic volumes, particularly near those urban areas where growth is anticipated. Significant impacts would not be expected.

Airports

Construction Phase

Although pipeline construction would occur adjacent to three airports with commercial service and two military airports it is not likely any significant impact would result. Planned runway expansion at the airport in Helena, Montana, should not be affected by the proposed pipeline. However, construction equipment working within restrictive areas or near facilities such as Very High Omnidirectional Range and Tactical Air Navigation Aids (VORTACs), Radar Microwave Link Receivers (RMLRs), and Air Route Surveillance Radars (ARSRs) could interfere with radiated signals and render the installations unusable during the construction phase. If any of these impacts were likely to occur, NTPC or its contractors would have to obtain permits from the Federal Aviation Administration (FAA). The FAA would shut down the affected facilities until construction was completed. Such shutdowns could result in local impacts of short duration. These would be minor, since affected air traffic would be provided with alternative navigation aids.

Additional passenger traffic and aircraft operations caused by pipeline system construction should be negligible.

Operation Phase

Inspection flights of the pipeline would normally be made every 2 weeks. These flights could penetrate the airport traffic areas of four commercial airports, one military airbase and numerous smaller general aviation fields. At Helena, Montana, and Williston, North Dakota, the inspection flights would pass close to airports with commercial service and substantial (25,000+ operations yearly) traffic.

Abandonment Phase

No significant impacts would be anticipated.

Electric Transmission

Construction Phase

The pipeline system would require construction of additional transmission lines as shown in table 3.2-23.

TABLE 3.2-23 NEW ELECTRICAL SYSTEM FACILITIES REQUIRED IF THE PROPOSAL IS IMPLEMENTED

Pump/Pressure Reducing Station1/	Serving Utility2/	New Transmission Facilities	Estimate of New Right-of-Way Area Required
Arlington 2	Snohomish County PUD	N/A	
Carnation 3	Puget Sound Power & Light	N/A	
Bandera 4	Puget Sound Power & Light	1 mile 115 kV line	12 acres
Ellensburg 5	Puget Sound Power & Light (Kittitas P.U.D. #1)	1 mile 115 kV line or 1/2 mile 115 kV line	12 acres 6 acres
Quincy 6	Grant County PUD	13 miles kV line	
Odessa 7	Lincoln Electric Coop	6 miles 115 KV line	73 acres
Plaza 8	Inland Power & Light	N/A	
Cataldo 9	Washington Water Power Co.	1.5 miles 115 kV line	18 acres
Enaville 10	Washington Water Power Co.	2 miles 114 kV line	24 acres
Paradise 11	Montana Power Company	N/A	
Potomac 12		N/A	
Elliston 13		N/A	
Townsend 14	Montana Power Company (Vigilante Electric Coop.)	N/A	
Harlowton 15		N/A	
Jordan 16		N/A	
Richey 17	Montana-Dakota Utilities Co.	N/A	
Tioga 18	Williams Electric Coop	8.5 miles 115 kV line	108 acres
Towner 19	Ottertail Power Co.	1 mile 115 kV line	13 acres
Devils Lake 20	North Dakota Rural Elecrtic Co-Op (Ottertail Power Co.)	N/A	
Crookston 21	Ottertail Power Co. (P.K.M. Electric Coop)	N/A	

Source: BPA 1978, Western Area Power Administration 1978, and NTPC 1978a
1/ Pump station 1 is included with the onshore storage facility, see section 3.1
2/ Several pump stations are located within the service areas of more than one utility and might be served by either.
N/A = Not available

In addition to the transmission lines shown in the table, distribution lines would be constructed to some block valves and possibly to some communications sites. Construction of new transmission and distribution lines would impact land uses as described in section 3.2 Land Use. There is no indication that utilities would be adversely impacted by this level of construction. The increased electric loads required for and induced by construction would be negligible.

The potential for physical damage to transmission lines and utility access roads would exist at each of the approximately 100 crossings and along the estimated 156 miles of adjacent or shared right-of-way. The pipeline would have to be located a sufficient distance from towers to prevent any undermining of footings, ground mats, or tower guys. The distance would vary according to the size of the tower and its footing. Where the pipeline parallels wood pole lines, existing guys could obstruct the pipeline and require adjustments. In some places pipeline trenching could trigger a landslide or result in dangerous tree problems by cutting root systems. Construction around transmission lines would increase the risk of equipment contact with towers or conductors which could cause an outage. Construction activities are subject to additional risks when separate utilities are constructed close to one another. Blasting while excavating could damage the powerline. Trenching across utility access roads could hamper maintenance approaches to the lines in emergency conditions, and access roads could be rendered impassable by heavy pipeline equipment. The significance of these potential impacts would depend on the location, extent, and type of physical damage incurred.

Right-of-way sharing might lessen the land use impact described in section 3.2 Land Use. The extent of this possible saving cannot be determined until more detailed studies are completed.

Operation Phase

The electric power requirements would represent significant load increases for a number of the serving utilities which, like Port Angeles City Light Department and Clallam County Public Utilities District, have expressed concerns about providing firm power to NTPC. Within the Pacific Northwest region, the possibility of power shortages depends upon such variables as weather conditions, conservation measures, and the completion dates of new thermal generating facilities. Although NTPC's proposal would increase the total energy demand to the Pacific Northwest region by less than 1 percent it would increase the firm energy deficit on the BPA system by about 5 percent and aggravate any shortages that might occur. As described in section 3.1 Transportation and Utility Networks, the impact on individual utilities would be the limitation of their ability to meet additional load growth. In view of the regional situation, this impact is considered significant.

Where the pipeline is located within or adjacent to electric transmission lines it could interfere with expansion of those transmission lines. This problem would be more acute when the pipeline was adjacent, or jogged into and out of an existing right-of-way. In such cases, and in areas already congested with other improvements, new transmission corridors might be required for expansion. Electrical interactions between pipeline and transmission lines would be possible when they paralleled or shared the same right-of-way. The effects of such interactions would be variable and depend on specific location, pipeline design, and electrical system conditions. It would be impossible to quantify these specific effects until the final location and design of the pipeline were determined. Longitudinally induced voltages in the pipeline could occur during steady state and transient conditions. Their effects would be influenced by pipeline design, the distance between pipe and transmission lines, and pipe insulation. Induced voltages on the pipeline near transmission structures could occur during electrical fault conditions on a transmission structure. The effect would depend upon the design of the pipeline and the distance between the transmission line structure and the pipeline. The cathodic protection system described in section 1.4 would prevent induced voltages hazardous to personnel or pipeline integrity. A significant impact in this regard appears unlikely.

An oil spill within the 156 miles of shared or adjoining right-of-way would cause vegetation loss, increase fire hazard, and risk damage to electrical transmission facilities during pipeline repair. The frequency of such an oil spill is estimated to be one every 2 years.

Shared and, to a lesser extent, adjacent rights-of-way would have positive impacts since less clearing would be required, existing access roads could be used, and visual impact would be reduced.

Abandonment Phase

Pipeline removal would again subject adjacent transmission lines to the possibility of physical damage similar to construction. Abandonment would decrease power consumption by approximately 2,018 million kilowatt hours per year. This would mean some loss of revenue for local utilities, but the additional power would be available to other users.

Communications

Construction Phase

Buried and overhead communication lines could be damaged and service disrupted by construction. This potential impact would probably occur near urban areas where communication lines are concentrated. The risk of such an event is relatively small since the pipeline would generally avoid urban areas. Were it to happen, however, it should not significantly disrupt service.

The amount of new communication facilities which would be constructed to serve the pipeline system is not known. One or more UHF or VHF radio relays might be required. Relays could generally be located where electric power and access is already provided to similar facilities. The construction of new communications facilities is therefore not likely to cause significant impacts.

Operation Phase

Pipeline system operation would probably not to have any adverse impact on communications systems.

Where the pipeline is adjacent to buried communication cables, they could be damaged by an oil spill or consequent repair activity. The significance of the impact would depend on the location and extent of the damage.

Abandonment Phase

Pipeline salvage operations could damage either overhead or buried communication systems; otherwise it would be unlikely to cause any significant impact.

Unaffiliated Pipelines

Construction Phase

Damage to other major pipelines would be a possibility at the approximately 69 crossings and along 286 miles of adjacent or shared right-of-way. Severity of impact would depend on the type of pipeline involved, as well as the location and extent of the damage.

Operation Phase

An adjacent pipeline could be damaged by interaction between the cathodic protection systems or an oil spill and resulting repair activity. Impact significance would depend upon the type of material transported in the other pipeline, the location, and the extent of the damage incurred. The anticipated frequency of oil spills on adjacent or shared right-of-way is estimated at one spill in 1.2 years.

Abandonment Phase

Removal of the pipeline could damage adjoining lines causing impacts similar to those discussed under construction.

RECREATION

In general the proposed pipeline would not, have major critical impacts on recreational use. However, specific areas and users are expected to be significantly impacted for varying periods of time generally less than one month.

Impacts are summarized in table 3.2-24. The expected intensity, duration, and type of impact is shown as well as the proposed project phase in which it would occur.

Green Point to Arlington, Washington (pipeline mile 0 to 69)

Construction Phase

The major concern would be the possible contamination of shellfish beds resulting from submarine pipe laying operations. Recreational collection along shoreline areas could be interrupted for several years. (See section 3.2 Marine Resources). The average number of recreational shellfish user trips for all areas which might be impacted is approximately 216,000 per year.

Tourists would experience problems with road congestion resulting from construction traffic on U.S. 101, State Highway 20 on Whidbey Island, and local roads in all areas. (See section 3.2 Transportation and Utilities Network).

Submarine pipeline laying operations would cause temporary disruption to boating and fishing areas. The degree of disruption would depend on construction timing. The length of disruption would generally not continue beyond three to four months.

Operation Phase

Normal operation of the proposed pipeline would not significantly affect marine or shoreline recreation.

A submarine pipeline rupture, however, would have a severe impact on marine related forms of recreation. A rupture of the submarine pipeline between Port Williams and Partridge Point might impact shorelines throughout central Puget Sound. If the rupture occured during the peak summer use season, shoreline recreational use by more than 1.4 million visitors could be curtailed in just the state parks of the area, assuming a one month containment and clean-up effort. Use of state shoreline parks represents only a small portionof the overall shoreline recreational use in the Puget Sound area.

TABLE 3.2-24 SUMMARY OF ANTICIPATED IMPACTS TO RECREATION: PIPELINE SYSTEM

Activity	Impact Intensity and Duration			Remarks	Significant Impacted Areas
	Construction	Operation	Abandonment		
Pleasure driving	←Low→ ←Permanent→			Construction and abandonment equipment and activities detract from pleasure driving Visual intrusion of linear corridor	Snoqualmie Pass Corridor Coeur d'Alene—Prichard—Prospect—Clark Fork Corridor Continental Divide Area
Hiking	Low Short term	None	Low Short term	Disruption of trail use during construction and abandonment. Assume all trails replaced	Pacific Crest National Scenic Trail Continental Divide National Scenic Trail Lewis and Clark National Historic Trail (two crossings)
Off road vehicle use	Low Short term	Low Long term	Low Short term	Use of existing areas interrupted during construction and abandonment; additional use attracted to access roads and pipeline corridor	Snoqualmie Pass winter sports area
Cross country skiing	None	Low Long term	None	Linear corridor would be unattractive to some recreationists, but attractive to others	Snoqualmie Pass winter sports area
Boating	←Low ←Short term→	Low to high	Low→	Boating is interrupted by construction or abandonment activities. Oil fouling of boats and gear by pipeline leak	Strait of Juan de Fuca Puget Sound Clark Fork—Blackfoot Rivers
Water-related activities including shellfish collecting, use of shorelines	Low Short term	Low to high Short to long term	Low Short term	Interruption by pipeline crews, possible loss of shellfish resource or beach areas from marine oil spill or pipeline rupture	Strait of Juan de Fuca Puget Sound Major river corridors
Fishing	Low Short term	Low to high Short to long term	Low Short term	Construction and abandonment activities may cause sediment in streams and affect spawning gravels. Noise harassment and temporary relocation of fish. Congestion at access areas. Oil spill or pipeline rupture would contaminate some fish and cause others relocate	All fishable rivers, marine fishing in Strait and Puget Sound
Hunting	←Low to moderate→ ←Short to long term→			Degree and duration dependent on type of wildlife	Skagit Wildlife Recreation Area Colockum Wildlife Recreation Area Praire Pothole Area Game management areas
Forest-related activities	←Low→ ←Short term→			Includes picnicking, camping, berry picking, wildlife viewing Activities interrupted, some less desirable as a result of the landscape alteration	None specifically identified
Cultural site visitation	Low to severe Short to long term	None	None	Activities may destroy or visually impair desirability of historic areas	Murray—Prichard Creek area McDonald Pass to Helena area Other isolated structures of historic interest

DURATION OF IMPACT

Short term Impact—an impact which occurs during the construction or abandonment phases and/or one to two growing seasons thereafter. A short term impact may also occur as a result of activities associated with the operation phase of the project.

Long term Impact—an impact which continues for an extended period of years; may be permanent.

INTENSITY OF IMPACT

Low Impact—an impact that will affect few recreationists due to the widespread availability of the resource opportunity, or, due to the short term effect of the impact.

Moderate Impact—an impact that will affect noticeable numbers of recreationists by eliminating the opportunity for recreational activities for the major portion of a use season.

High Impact—an impact that will affect the majority of recreationists for one or more recreational seasons, or, an impact that has permanently changed the availability of the resource to recreationists.

Oil contamination of shellfish beds in Admiralty Inlet and from Dungeness Spit to Port Townsend would curtail this recreational activity during a minimum 4-year shellfish recovery period. Based on past use, this would eliminate more than 384,000 visits over a four year period.

A rupture occurring in the submarine pipeline between Whidbey and Camano Islands would similarly impact 676,000 shoreline state park recreationists and more than 480,000 visits by recreational shellfish collectors.

At the Skagit Wildlife Recreation Area losses would probably occur which would detract from recreational use of the area. If the vestiges of such a spill lasted for 1 year, it would discourage or detract from more than 70,000 recreational visits.

Other recreational activities such as pleasure boating and fishing would be lost or diverted to other areas for the period of containment and clean-up.

Losses to area tourism (visitors not engaged in a specific recreational activity) are difficult to assess because information on tourist use is not available. Tourist visits to shoreline areas would probably be greatly reduced following a submarine pipeline rupture for the remainder of the tourist (summer) season. Adjacent areas may experience much greater tourist and recreational use which might lead to overcrowding.

Abandonment Phase

Impacts occuring during abandoment would be similar to those incurred during construction along the land segments. Impacts to marine resources or recreationists are not anticipated because the submarine pipeline would probably not be removed.

Arlington, Washington to Canyon Ferry Reservoir, Montana (pipeline mile 69 to 690)

Construction

The Snoqualmie Pass area sustains year-round use by approximately one-half million recreationists (SRI, International 1978). Summer recreationists may be inconvenienced by road congestion enroute to camp, day use, or fishing and areas by equipment noise and right-of-way clearing activities along the proposed corridor. Hunter success would not likely be affected. Angler success at, and downstream, from pipeline crossings would be reduced for several weeks.

Construction across the Pacific Crest National Scenic Trail would interrupt use at one of the most popular trail heads in the area for a period of about one week.

Between Heyburn State Park and Cataldo, most recreational activities would be interrupted during construction. Increased road congestion and noise would reduce recreational satisfaction thoughout this area. Reduced success in waterfowl and big game hunting would likely occur one or two seasons. Turbidity at and downstream from river crossing, fish relocation, and noise in the area would reduce angler success for several days to weeks. Dispersed and nonconsumptive activities such as picnicking, driving for pleasure, and wildlife viewing would be less desireable for periods of at least several weeks and perhaps longer if road damage and visual scars occur.

Cleared pipelines and access road rights-of-way could provide recreational opportunities

U.S. Forest Service

Off-road vehicle ruts on cleared right-of-way.

Bureau of Land Management

U.S. Fish and Wildlife Service

Along the Clark Fork River corridor from Thompson Falls to Paradise, construction activity would lessen the quality of recreational activities. Angler success near and downstream from pipeline crossing would be adversely affected for several days to weeks as a result of construction noise, stream or river turbidity, and fish relocation. Other water-related recreation such as float boating, swimming, or otherwise enjoying the river would be similarly interrupted for periods of several days to weeks. Opportunities for forest-related activities such as hiking, camping and wildlife viewing would be reduced as a result of road congestion and noise. Hunting for big game occurs throughout this area. Construction activity and the resultant wildlife habitat alteration might reduce hunter success for one season. In some cases, hunter success might ultimately be improved because of the increased access and increased areas of browse vegetation.

The Continental Divide National Scenic Trail would be crossed over near Helena, Montana. Loss of scenic values along the trail and observed from the trail would occur and would last the life of the project.

Hunter success for deer, elk, mountain lion, and bear might be lessened for one or two hunting seasons depending on the timing of construction activities. Temporary road congestion and construction activity near lower Canyon Ferry Reservoir would probably cause reduced waterfowl hunting for one season.

Operation Phase

Normal operation of the pipeline would have few impacts on recreationists. Unauthorized off-road vehicle use of the right-of-way and adjacent access roads would probably occur in some areas. Off-road vehicle use might adversely affect hunter success for game such as elk along the right-of-way and in nearby areas. However, other recreationists such as snowmobilers would be attracted to the linear corridor for winter recreation. Increased access might improve hunter success in some areas.

A pipeline rupture would primarily affect water-related recreation. Anglers would be severely impacted by a leak into the Coeur d'Alene River system or Lake, Prichard Creek, Prospect Creek, or Thompson, Clark Fork and Blackfoot Rivers. Contamination of fish and shoreline areas would affect one season of use. Other nearby areas would likely experience an increase in angler use.

Waterfowl hunting might be adversely affected in the Coeur d'Alene or Canyon Ferry areas as a result of water source contamination. Effects on hunters would be most significant if migratory waterfowl during hunting season were affected. Hunter success might be noticeably reduced for one or more seasons depending on the severity of the impact to waterfowl.

Abandonment Phase

Impacts on recreational activities would be similar to those occuring during the construction phase. The cleared right-of-way and access roads might continue to invite off road vehicle use. As a result, hunter success might continue to be reduced in some areas and increased in others.

Canyon Ferry Reservoir, Montana to Clearbrook, Minnesota (pipeline mile 690 to 1,491

Construction Phase

Float boaters and anglers on upper stretches of the Missouri River would be inconvenienced for a period of several days to weeks by congestion, noise, and turbidity around takeout points and by the temporary relocation of fish. The degree of inconvenience would be dependent upon the timing of construction and amount of turbidity.

Construction across the newly designated Lewis and Clark National Historic Trail would inconvenience users of this trail during a 1- to 2-week construction period. Visual evidence of the pipeline's existence would continue to detract from user's enjoyment of the trail.

Antelope, deer, and upland game birds are hunted throughout eastern Montana, areas of North Dakota, and in fields and shelter belts of Minnesota. Displacement of wildlife due to construction activity and habitat alteration might lessen hunter success for one season.

If construction coincides with hunting season, hunters in these areas might also be inconvenienced by construction crew occupation of areas previously used as hunting camps.

Waterfowl hunting in the game management areas or along refuge boundaries in the vicinity of construction activity would be lost for the duration of construction, one or two weeks in each area.

Nonconsumptive wildlife recreation such as viewing and photography would be adversely impacted by the change in habitat and relocation of wildlife, for periods of one to two weeks in each area.

Congestion at river access points, turbidity from sedimentation causing relocation of fish would detract from and reduce angler success on the Missouri, Little Muddy, White Earth, Souris, Turtle, and Red Rivers. This type of disturbance would be short term lasting for periods of actual stream crossing construction and possibly several days beyond.

Use of small county or municipal parks by construction crews and their families might contribute to deterioration of these areas. Most county and municipal park budgets are limited and use by construction personnel could adversely impact small towns along the route. Noise from construction activities would inhibit use of Turtle River State Park for a period of up to one month.

Operation Phase

Normal operation of the pipeline would not have significant impacts on recreational activities. Some wildlife would be favorably impacted by the increase in browse which might increase hunter success for game species such as deer. Other game such as elk are likely to avoid right-of-way areas. The use of the right-of-way or access roads by off road vehicles might conflict with other recreational uses such as hunting and hiking.

An oil spill would primarily impact recreationists dependent on river or water resources. An oil spill in a river or stream would eliminate angler use during clean-up and might reduce angler use for more than one season until fish populations were reestablished.

Oil contamination of pothole lakes would cause waterfowl mortality and displacement and might noticeable reduce hunting and viewing in the affected area for one or more seasons.

An oil spill into the Turtle River would significantly detract from recreational use of the Turtle River State Park in North Dakota which receives approximately 158,000 visits a year.

Abandonment Phase

Impacts on recreational activities would be similar to those occurring during the construction phase. Continued use of abandoned right-of-ways and access roads by off road vehicles might occur in some areas.

ECONOMIC CONDITIONS

Fisheries

Construction Phase

Losses to marine resources resulting from installation of the submarine pipeline across Puget Sound would be reflected in diminished sport and commercial catches. Geoducks, clams, shrimp, crab, oysters, herring, and bottomfish would suffer the most noticeable reductions. Economic losses would persist for several years until populations recovered to preconstruction levels. Reduced salmon production from pipeline construction across salmon spawning streams should not significantly affect the sport or commercial catches.

Operation Phase

Fisheries in Puget Sound would suffer significant losses if an oil spill occurred. Salmon catches could also be significantly impacted by an oil spill. An oil spill along the pipeline route would generally have minor, local impacts on sport fishing catches. Limited commercial fisheries exist along the route, mainly in eastern Montana and North Dakota.

Abandonment Phase

There would be no significant economic impacts during the abandonment phase.

General Economic Methodology for Construction Impacts

The work force and local construction expenditures were estimated by month and allocated to local areas along the pipeline route. Income generated from construction workers expenditures and local procurement by pipeline contractors in these areas was estimated and resulting additional employment was derived. Employment estimates were differentiated into local and non-local components. Transient population was estimated by factors representing the additional family members expected to accompany transient workers. This analysis yielded county-by-county estimates of construction workers, additional total and local employment, transient population and additional children, and local income generated. (Methods used in estimating other economic impacts are described where those impacts are discussed.) The analysis involved the following steps described in detail below:

- Estimation of construction work force and schedule;
- Estimation of local construction expenditures;
- Location of construction work force;
- Estimation of local and non-local components of work force;
- Estimation of induced income and employment; and
- Estimation of transient population.

Construction Work Force and Schedule

NTPC provided estimates of the size and timing of the construction work force. Independent estimates of manpower requirements based on payroll estimates and average wage levels were developed. These estimates indicated a larger work force than that reflected in the schedule, and were adopted as representative of worst-case conditions.

Average monthly wages were estimated as shown in Table 3.2-25. For the project as initially proposed, payroll estimates furnished by NTPC were divided by average wages to obtain man-power requirements in man-months. Work schedules were adjusted to reflect these requirements. The scheduling of pump station and delivery facility construction was also adjusted to reflect worst-case conditions by assuming that work on these facilities would occur at maximum work force levels coincident with pipeline construction.

These estimates were revised on the basis of changes in construction costs for the revised proposal. Work force requirements for the submarine crossing of Puget Sound and Saratoga Passage were estimated at a maximum 300 workers employed for 900 man-months over a 4-month period. A larger work force than that for the Ediz Hook-Green Point crossing was assumed because of the greater difficulty of the crossing. Time required was based on equipment use times indicated in a confidential report of an NTPC consultant.

Revised payroll and man-month estimates are shown in table 3.2-26, and the adjusted work schedule in table 3.2-27.

Local Construction Expenditures

Local expenditures would include payrolls and some supplies and services. Local contractor procurement consists of fuel, concrete, lumber, select fill, gravel, asphalt, and fence as shown in table 1.2-10. NTPC's estimates of fuel consumption were used to develop estimates of fuel costs. As shown in table 3.2-28, the procurement estimates were converted to amounts per man-month for purposes of the analysis.

Location of Construction Work Force.

The principal factors affecting worker location community size and distance from work site (Old West Commission 1976). Worker location, may also be influenced by availability of specific facilities, crowdedness, road conditions. A pipeline project presents special problem in determining work force location because work goes on at a number of places simultaneously, and work sites are continually changing. In order

TABLE 3.2-25 AVERAGE MONTHLY WAGE BY CONSTRUCTION FACILITY

Occupation	No. of Workers	Wage Rate	No. of Workers	Wage Rate	No. of Workers	Wage Rate	No. of Workers	Wage Rate	No. of Workers	Wage Rate
	Pipeline Sections									
	Sec. 1-2		Sec. 3-4		Sec. 5-7		Sec. 8		Sec. 9-10	
Supervisory & Office	37	13.15	57	13.15	57	12.90	36	12.90	36	12.90
Welders	44	13.15	38	13.15	38	12.90	48	12.90	48	12.90
Welder Helpers	45	8.77	37	8.77	37	7.66	45	7.66	45	5.95
Operators	106	13.06	75	11.80	75	10.76	84	10.76	84	11.05
Teamsters	51	12.48	37	14.42	37	9.71	47	9.71	47	7.77
Semi-skilled	29	10.12	32	9.65	32	8.80	59	8.80	59	6.56
Unskilled	168	9.92	164	9.45	164	8.60	81	8.60	81	6.36
	480		440		440		400		400	
Average monthly Wage	$3,400		$3,232		$2,978		$3,003		$2,660	
	Pump Stations									
	Sta. 1-4		Sta. 5-11		Sta. 12-18		Sta. 19-21			
Supervisory	15	13.15	15	13.15	15	12.90	15	12.90		
Skilled	11	13.15	11	13.15	11	12.90	11	12.90		
Operators	3	13.06	3	11.80	3	10.76	3	11.05		
Teamsters	32	12.48	32	11.42	32	9.71	32	7.77		
Semi-skilled	43	10.12	43	9.65	43	8.80	43	6.56		
Unskilled	18	9.92	18	9.45	18	8.60	18	6.36		
	122		122		122		122			
Average monthly Wage	$3,428		$3,265		$2,979		$2,493			
	Marine Terminal Facilities [1]									
	Unloading		Marine P/L		Storage					
Supervisory & Office	11	12.85	32	12.85	24	12.85				
Skilled	24	11.85	41	11.85	54	11.85				
Operators	6	11.75	41	11.75	12	11.75				
Teamsters	5	11.50	21	11.50	10	11.50				
Semi-skilled	19	9.52	18	9.52	42	9.52				
Unskilled	25	8.94	90	8.94	58	8.94				
	90		243		200					
Average monthly Wage	$3,650		$3,663		$3,639					
	Delivery Facilities									
	Glacier		Western		Amoco		Clearbrook			
Supervisory	23	12.90	22	12.90	15	12.90	20	12.90		
Skilled	69	12.90	55	12.90	24	12.90	45	12.90		
Operators	12	10.76	12	10.76	9	11.05	11	11.05		
Teamsters	3	9.71	3	9.71	3	7.77	3	7.77		
Semi-skilled	47	8.80	43	8.80	37	6.56	40	6.56		
Unskilled	23	8.60	21	8.60	17	6.36	18	6.36		
	177		156		105		137			
Average monthly Wage	$3,316		$3,290		$2,791		$2,979			

Note: Average monthly wage calculated on the basis of a 60-hour work week with time and half pay over 40 hours, or the equivalent of 257.14 hours pay per month. Hourly wage rates (effective 7/1/78) for the pipeline, pump stations, and delivery facilities were furnished by NTPC from the Pipe Line Labor Manual. Wage rates for marine terminal facilities were derived from construction union agreements with the Seattle Chapter, Associated General Contractors. The occupational distributions of work force were furnished by NTPC.

[1] Skilled workers at iron workers' scale; supervisory and office workers at $1.00 premium. Overtime at double time rate.

TABLE 3.2-26 CONSTRUCTION MAN-MONTHS

Code 1/	Facility Pipeline Sections 2/	Payroll (.10^3)	Average Wage	Man-Months
55,1,2	1	$19,459*	$3,400	5,723*
3,4	2	14,205*	3,400	4,178*
4,6	3	14,983*	3,232	4,636*
7,8	4	15,877*	3,232	4,912*
9,10	5	12,247	2,978	4,112
11,12	6	10,036	2,978	3,370
13,14	7	13,100	2,978	4,399
15,16	8	12,282	3,003	4,090
17,18	9	11,400	2,660	4,286
19,20	10	10,162	2,660	3,820
	Pump Stations:			
	Total	66,452*	-	-
36	Jordan (#6)	581	2,979	195
39	Towner (#19)(future)	-	2,493	-
41	Crookston (#21)(future)	-	2,493	-
3/	Each Other Station	4/	4/	279
44	Unloading facility	7,783	3,650	2,132
45	Ediz Hook Submarine P/L	3,104	3,663	847
46,47	Onshore Storage 2/	11,806	3,639	3,244
53,54	Cross Sound P/L	3,297*	3,663	900*
	Delivery Facilities:			
48	Glacier	2,279	3,316	687
49	Western Crude	1,720	3,290	523
50	Amoco	1,258	2,791	422
51	Clearbrook	433	2,979	155

Note: Payroll data from NTPC adjusted for project revisions; average wage per month from table 3.2-25.

* Revised to reflect project changes

1/ Facility codes identify the construction activities associated with each facility. When more than one facility code is assigned, the numbers refer to the segments into which the facility work effort in man-months is divided in order to represent different time periods and geographical locations. Pipeline section 1 is divided as follows: Code 55 - 663 man-months; Code 1 - 2,530 man-months, and Code 2 - 2,530 man-months. These segments correspond with construction in Clallam County (Code 55), 12 miles out of 102 land miles in section 1; and construction on Whidbey Island and the mainland, the remaining 90 land miles divided into two equal segments of 45 miles each (Codes 1 and 2). The other land pipeline construction sections are each divided into two equal segments. The first segment represents construction activity on the western half of the section and the second segment, construction on the eastern half. The Cross-Sound submarine pipeline work is divided into two segments representing work on the Admiralty Inlet crossing (Code 53 - 734 man-months) and the Saratoga Passage crossing (Code 54 - 166 man-months). System test activities for the onshore storage facility (in months 17-22 of the construction period) are identified as Code 47 (150 man-months), but pipeline system test activities are not separately identified.

2/ Includes system test force.

3/ Facility codes 21-35,37,38 and 40.

4/ See table 3.2-25 for pump station average wage. Payroll for each station is equal to man-months times average wage.

TABLE 3.2-28 LOCAL PROCUREMENT ESTIMATES

Type of Facility	Fuel 1/	Other 2/	Total	Man-Months	Amount Per Man-Month
Unloading Facilities	$ 6,700	$1,304,000	$ 1,310,700	2,132	$614.8
Submarine Line	NA	896,000	896,000	1,747	512.9
Onshore Storage	50,700	416,000	466,700	3,244	143.9
Pump Stations	621,250	880,000	1,501,250	5,219	287.7
Pipeline	10,589,000	160,000	10,749,000	43,526	247.0
Delivery Facilities	NA	82,000	82,000	1,787	45.9

1/ Derived from partial information on fuel consumption supplied by NTPC.

2/ Includes concrete, lumber select fill, gravel, asphalt and fence from table 1.4-17.

to deal with these considerations, a simple estimating technique involving some judgment was adopted.

Discussions with NTPC officials indicated that work on each pipeline section would progress from west to east with operations centralized around a contractor headquarters which would be relocated once during the construction period. To decide where workers would lodge, and when, the work effort in man-months for each pipeline construction section was divided into two or more segments, each representing a separate portion of the time period and a different geographical location. The submarine pipeline crossing Puget Sound was divided into two unequal segments representing the Puget Sound and Saratoga Passage crossings, respectively. Based on the likely construction methods, the bulk of this work force was assumed to be water-based, commuting to land by crew boat. Pipeline construction section 1 (from Green Point to North Bend) was divided into three segments; construction on the Olympic Peninsula, and construction on the mainland in two equal segments. Other pipeline construction sections were each divided into two equal segments of about 50 to 110 miles in length. Counties with population centers within commuting distance (50-75 road miles) of any part of the segment were listed, and a percentage distribution of their population was calculated. (County populations were assumed to be concentrated in the vicinity of their largest population center.) Population percentage distributions were adjusted to reflect where workers would locate, based on relative travel distance, position relative to the whole construction section, and community facilities. These percentage distributions were then used to allocate the work force for each pipeline segment. The same technique was used for fixed site construction facilities with the exception of pump stations. Because the maximum pump station work force was small (23 workers), it was assigned entirely to the county in which the work site was located.

Distributions are shown in Table 3.2-29.

Local and Non-local Components of the Work Force

Pipeline contractors as well as a portion of the pipeline work force are likely to come from outside the state in which construction occurs. Estimates of the out-of-state proportion of the pipeline work force were based on estimates by occupation as shown in Table 3.2-30.

Table 3.2-27 CONSTRUCTION WORK FORCE BY MONTH

Code[1]	Facility	1980	1981											1982								
		D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Marine Terminal																						
44	Tanker unloading facility	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	92				
45	Harbor pipeline	243	243	243	118																		
46	Onshore storage facility	70	70	70	70	70	200	200	200	200	200	200	200	200	200	200	200	200	200	144			
47	System test																	25	25	25	25	25	25
53, 54	Cross-Sound [6]					134	300	300	166														
	Pipeline section[6]																						
55, 1, 2	1			221	480	480	480	480	480	480	480	480	480	480	480	221							
3, 4	2				472	480	480	480	480	480	480	480	331										
5, 6	3					432	440	440	440	440	440	440	440	440	440	229							
7, 8	4					432	440	440	440	440	440	440	440	440	65								
9, 10	5					432	440	440	440	440	440	440	440	145									
11, 12	6					432	440	440	440	440	440	440	283										
13, 14	7					432	440	440	440	440	440	440	440	440	432								
15, 16	8					392	400	400	400	400	400	400	400	400	400	83							
17, 18	9					392	400	400	400	400	400	400	400	400	400	279							
19, 20	10					392	400	400	400	400	400	400	400	400	213								
21-41	Pump Stations[2] [3]						840	882	882	882	882	867	540										
	Delivery facilities[4]																						
48	Glacier							78	177	177	177	78											
49	Western Crude								28	156	156	156	27										
50	Amoco								6	137	137	137	5										
51	Clearbrook, MN[5]								25	105	25												
52	System test																	25	25	25	25	25	25

Source: NTPC 1979

[1] See footnote, table Construction Man-Months for definition of facility codes.

[2] Approximately 278 man-months would be required per pump station. Stations are expected to be constructed in an overlapping mode over a 16 month construction period, December 1979-March 1981. Peak work force at each station would be 42 workers. To obtain estimates of maximum potential impacts, construction for all pump stations is assumed to occur at the same time and coincident with pipeline construction.

[3] The construction time for station 16 (Code 36) is estimated at 70 percent of typical station construction time. There would be no construction at stations 19 (39) and 21 (41) in the initial phase.

[4] Delivery facilities would be constructed over a 16 month period December 1979-March 1981. To estimate maximum potential impacts, construction is assumed to occur at maximum work force levels coincident with other construction work.

[5] Omits work force which might be required for construction of additional tankage for receiving pipelines at Clearbrook.

[6] Underlined figures indicate the month in which transition was made from one work segment to another in pipeline construction, as described under "Location of Construction Work Force."

Table 3.2-29 ALLOCATION OF CONSTRUCTION WORK FORCE AND MARKET CLASS OF COUNTIES

State Code	County Code	County	Population (10³)	BEA Region	Market Class	2nd Level Market	3rd Level Market	Facility Codes and Work Force Percentages					
10	01	Clallam[1]	44.1	155	2		007	55 85	53 5	44 100	46 95	47 95	45 100
10	02	Jefferson	13.5	155	1	001	007	55 15	53 23			46 5	47 5
10	03	Kitsap	136.2	155	2		007						
10	61	Island	43.2	155	1	064	007	1 20	53 62	54 33			
10	62	Whatcom	100.3	155	2		007						
10	63	Skagit	57.6	155	2		007	1 30	53 10	54 33			
10	64	Snohomish	307.3	155	2		007	1 50	2 55	54 34	22 100		
10	07	King	1210.6	155	3				2 45	3 50	23 100	24 100	
10	08	Kittitas	26.0	156	1	010	010	4 85		3 50	25 100		
10	09	Chelan	44.2	156	2		010	4 5					
10	10	Yakima	160.4	156	3			4 5					
10	11	Douglas	21.7	154	1	012	015		5 5				
10	12	Grant	48.1	154	2		015	4 5	5 90	6 5	26 100		
10	13	Lincoln	9.9	154	1	015	015		5 1	6 10			
10	14	Adams	14.9	154	1	015	015		5 2	6 10	27 100		
10	15	Spokane	317.2	154	3			7 43		6 72	28 100		
10	16	Whitman	43.6	154	2		015			6 3			
20	17	Kootenai	52.4	154	2		015	7 45	8 5		29 100		
20	18	Benewah	7.8	154	1	017	015	7 10	8 2				
20	19	Shoshone	18.6	154	2		015	7 2	8 65		30 100		
30	20	Sanders	8.7	153	1	023	023	10 4	8 28	9 30	31 100		
30	21	Mineral	3.8	153	1	023	023	10 4		9 20			
30	22	Lake	18.2	153	2		023	10 2		9 10			
30	23	Missoula	71.2	153	3			10 90	11 68	9 40	32 100	12 5	
30	24	Granite	2.7	153	1	023	023		11 5	12 2			
30	25	Powell	8.0	153	1	023	023		11 10	12 3	33 100		
30	26	Deer Lodge	14.8	153	1	027	023		11 2	12 2			
30	27	Silver Bow	43.1	153	2		023		11 5	12 5			
30	28	Lewis and Clark	40.9	94	2		031	13 25	11 10	12 79			
30	29	Jefferson	7.3	94	1	028	031	13 5		12 2			

Source: BLM 1979

Note: The information for BEA region, market class, and 2nd and 3rd level markets is explained in the text under "Induced Income and Employment." The facility code and work force percentage information shows in each column and represents the facility code and the percentage of that facility work force allocated to the county indicated. Facility code numbers are shown in table Construction Man-Months.

[1] Clallam County also allocated the work force for pump station 1 (Code 21-100%)

Table 3.2-29 ALLOCATION OF CONSTRUCTION WORK FORCE AND MARKET CLASS OF COUNTIES

State Code	County Code	County	Population (10³)	Bea Region	Market Class	2nd Level Market	3rd Level Market	Facility Codes and Work Force Percentages					
30	30	Broadwater	3.0	94	1	028	031	13 23		12 2	34 100		
30	31	Cascade	85.1	94	3								
30	32	Meagher	2.2	94	1	031	031	13 18					
30	33	Judith Basin	2.6	94	1	031	031	13 2					
30	34	Wheatland	2.0	94	1	031	031	13 17	14 10		35 100	48 25	
30	35	Fergus	13.1	94	2		031	13 9	14 62				48 70
30	36	Golden Valley	.9	95	1	039	039	13 1	14 4				48 5
30	37	Petroleum	.7	94	1	035	031		14 3	15 12			
30	38	Musselshell	4.4	95	1	039	039		14 21				
30	39	Yellowstone	109.1	95	3								
30	40	Garfield	1.7	95	1	039	039			15 50	36 100		
30	41	McCone	2.5	95	1	043	039	16 10		15 38			49 10
30	42	Custer	13.5	95	2		039						
30	43	Dawson	11.9	95	2		039	16 10					
30	44	Roosevelt	10.8	93	2		048	16 20				49 44	
30	45	Richland	11.2	93	2		048	16 30			37 100	49 46	
40	46	Williams	18.9	93	2		048	16 30	17 32		38 100		
40	47	Montrail	8.5	93	1	048	048		17 15				50 31
40	48	Ward	67.3	93	3				17 53	18 70			
40	49	McHenry	8.4	93	1	048	048			18 9	39 100		
40	50	Pierce	6.0	93	1	048	048	19 2		18 7			
40	51	Towner	4.3	92	1	053	055	19 7		18 2			
40	52	Benson	8.4	92	1	053	055	19 15		18 6			
40	53	Ramsey	13.5	92	2		055	19 23		18 6	40 100		
40	54	Nelson	5.1	92	1	055	055	19 9	20 4				
40	55	Grand Forks	73.1	92	3			19 44	20 53				
50	56	Polk	34.8	92	2		055		20 25		41 100		51 17
50	57	Red Lake	5.2	92	1	056	055		20 3				51 10
50	58	Clearwater	8.3	92	1	059	055		20 5				51 28
50	59	Beltrami	30.2	92	2		055		20 10				51 45

Source: BLM 1979

Note: The information for BEA region, market class, and 2nd and 3rd level markets is explained in the text under "Induced Income and Employment." The facility code and work force percentage information shows in each column and represents the facility code and the percentage of that facility work force allocated to the county indicated. Facility code numbers are shown in table Construction Man-Months.

[1] Clallam County also allocated the work force for pump station 1 (Code 21-100%)

TABLE 3.2-30 OUT-OF-STATE PROPORTION OF PIPELINE WORK FORCE

		Pipeline Construction Sections 2/		
Occupation	Percentage by Occupation 1/	1 & 2	3 - 7	8 - 10
Supervisory & office	80	35	53	34
Welders	100	44	38	48
Welders helpers	20	45	37	45
Operators	50	106	75	84
Teamsters	50	51	37	47
Laborers	20	197	196	140
Other	20	2	4	2
		480	440	400
Average Proportion 3/		41%	42%	45%

1/ SRI International 1978
2/ NTPC, 1979
3/ Weighted average of percentages by occupation

For other facilities, the out-of-state proportion of the work force was derived from estimates of non-resident workers furnished by NTPC:

	Percent
Tanker unloading facility	4
Submarine pipelines	41
Onshore storage	13
Delivery facilities	15

The Mountain-West Research study of pipeline construction workers (1979) shows that local workers varied from about 1.5 percent to over 60 percent of the construction work force. Variations were attributable to the size of the local population and to the amount of local pipeline experience. It was assumed that the local proportion of the in-state work force (55 to 100 percent of the total work force for each facility), would range from 2 percent in a county of 1,000, to 35 percent in a county of 100,000 or more, and that it would vary uniformly between those population sizes. (For example, the local share of the in-state component would amount to between 10 and 16 percent of a specific facility work force allocated to Clallam County).

Induced Income and Employment

Expenditures by construction workers and contractors locally would generate additional income and employment in the area. Additional income and employment was estimated by using regional gross output multipliers developed by the Bureau of Economic Analysis (BEA 1977). Gross output is income less the cost of goods sold of all business establishments in an area. These multipliers represent the total regional gross output increase resulting from a unit increase in final demand. Final demand is an increase in income coming from outside the regional economy, and is measured in this case by the initial gross receipts (or gross margins) of businesses selling to construction workers or contractors. (Cost of goods sold is excluded for trade businesses).

The portion of construction workers expenditures accruing to local businesses; final demand from payrolls. Expenditures would be a relatively small proportion of payrolls because worker income would be high. Average income for construction workers (payroll minus social insurance contributions) was assumed to be about $40,000 a year. The average ratio of consumption to income for the United States from 1973 to 1977, was 77.8 percent (Department of Commerce Survey of Current Business). The average ratio for families with income of $20-25,000 was 56.9 percent, and with income of over $25,000, 44.4 percent, according to the 1972-3 Consumer Expenditure Survey of the Bureau of Labor Statistics. Adjusting for inflation and data differences, expenditures by construction workers were estimated to be 54.8 percent of payrolls, but only half of the non-local workers expenditures, or 27.4 percent of payrolls, were assumed to occur locally.

BEA multipliers are calculated for individual industries. Individual industry multipliers were each weighted by the proportion of consumption expenditures represented by that industry. In order to develop multipliers for consumption expenditures in a number of different industries. The distribution of consumption expenditures for industries representing one percent or more of the total was derived from data presented in the Survey of Current Business, February 1974. Computation of the consumption multipliers is shown in Table 3.2-31. Application of these multipliers to final demand yielded gross output estimates. Personal income is that part of gross output accruing to individuals in the form of wages, profits, rents, etc. The BEA study included a technique for estimating personal income as measured by earnings (wages and salaries, other labor income and proprietors income). Earnings are computed as the fraction of gross output accruing to workers and proprietors in the initially affected industry plus a fraction (.3008) of the gross output generated in all other industries. The latter fraction represents the national ratio of earnings to gross output for all industries. Individual industry earnings ratios were converted to composite figures for consumption expenditures, and are also shown in table 3.2-31.

Additional employment generated by increased final demand was estimated by dividing personal income by the average monthly wage in the respective states. Average monthly wage levels for 1977 obtained from state employment agencies were: Washington, $1,074; Idaho, $888; Montana, $862; North Dakota, $820; and Minnesota, $956.

For construction procurement expenditures, final demand was assumed to affect mainly the fuel distribution industry. Gross margins in this industry are about 51 percent of gross income (Survey of Current Business, February, 1974), so final demand was taken to be 51 percent of procurement. Multipliers and earnings ratios are shown in table 3.2-32.

Estimates were developed using multipliers for regions involving a number of counties and focusing on a major market center. It was considered desirable to make estimates for such multi-county areas in order to give recognition to interrelationships among communities in these regions. The additions do not accrue entirely within the county where the initial expenditure occurred. A large part of the income generated in smaller areas flows out to larger nearby communities (second level market centers), or to regional market centers. Market relations among counties were specified in accordance with a model developed by J.A. Chalmers (1977). Market centers serving other smaller communities in their immediate vicinity were termed second level market centers, and the largest community in a region was termed a third level market center. Each county was assigned a market class (1, 2, or 3) and the higher level

TABLE 3.2-31 GROSS OUTPUT MULTIPLIERS AND EARNINGS RATIOS FOR CONSUMPTION EXPENDITURES

WRC Sector	Description	Percent of Consumption	Earnings Ratio	Region									
				Grand Forks 92	Minot 93	Great Falls 94	Billings 95	Bismarck 96	Fargo 97	Butte 5/ 153	Spokane 154	Seattle 155	Yakima 156
19-34	Food products 1/	13.56	.132	1.860	1.757	1.906	2.229	1.799	1.956	2.141	2.388	2.476	2.310
35	Tobacco mfg.	1.17	.076	-	-	-	-	-	-	-	-	-	-
36	Apparel, etc.	4.49	.238	1.409	1.396	1.475	1.589	1.422	1.451	1.659	1.646	2.024	1.657
42	Chemicals, etc.	1.75	.193	1.390	-	1.578	1.736	-	1.439	1.813	1.725	2.272	1.912
43	Petroleum &	2.26	.084	1.352	1.875	2.088	2.325	1.729	1.443	-	2.238	2.975	1.364
50	Elect. equip.	1.91	.308	1.526	1.510	-	1.699	1.536	1.566	-	1.943	2.387	1.742
51	Transp. equip	3.76	.267	1.565	-	1.591	1.824	1.616	1.548	2.025	1.982	2.859	1.801
52	Misc. mfg.	1.42	.297	1.537	1.489	1.677	1.778	1.540	1.599	1.881	1.983	2.545	1.887
53	Transp., comm. & util.	7.37	.311	1.585	1.614	1.771	1.999	1.698	1.711	2.021	1.989	2.517	1.880
54	Trade	5.11 2/	.513	1.853	1.847	2.055	2.217	1.899	1.939	2.339	2.345	2.969	2.203
55	Fin., ins., r.e.	21.37	.160	1.380	1.347	1.635	1.694	1.459	1.507	1.727	1.801	2.268	1.692
56	Services	16.63	.487	1.855	1.856	2.071	2.245	1.912	1.953	2.365	2.372	2.998	2.204
		80.80											
Weighted Multiplier 3/				1.626	1.623	1.817	1.983	1.683	1.722	2.028	2.090	2.566	1.958
Weighted Earnings Ratio 4/				.219	.220	.220	.221	.220	.220	.223	.222	.224	.221

Source: Industry gross output multiplier and earnings ratios from Bureau of Economic Analysis, 1977. For consumption percentages, see text. The weighted earnings ratio was corrected by a factor of .77 on instruction from BEA to correct for the overcounting of earnings in the household industry.

1/Average value for industry components weighted by total national value of shipments.
2/Percent of consumption for trade represents gross margins (21% of sales). Cost of goods sold omitted.
3/Weighted multiplier - $m_i f_i$, where m_i = regional industry multiplier, and f_i = the fraction of consumption represented by that industry.
4/Weighted earnings ratio = .77 x 1/M x $m_i f_i (e_i \, 1/m_i + .3008 \, (1 - 1/m_i))$, where M = the weighted multiplier and e_i = the industry earnings ratio.
5/The central city of the Butte region (153) was regarded as Missoula.

TABLE 3.2-32 GROSS OUTPUT MULTIPLIERS AND EARNINGS RATIOS
FOR PROCUREMENT EXPENDITURES

BEA Region	Industry Multiplier	Earnings Ratio 1/
92 Grand Forks	1.853	.320
93 Minot	1.847	.320
94 Great Falls	2.055	.331
95 Billings	2.217	.305
96 Bismarck	1.899	.318
97 Fargo	1.939	.316
153 Butte	2.339	.301
154 Spokane	2.345	.300
155 Seattle	2.969	.287
156 Yakima	2.205	.306

Source: Bureau of Economic Analysis, 1977

Note: Procurement expenditures were treated as purchases from the fuel distribution industry. The regional industry multipliers are those for the trade industry of which fuel distribution is a part.

1/ The national earnings ratio for the industry is .513, and .3008 for all industries combined. Regional earnings ratios were calculated by the following formula:

$$\text{Earnings ratio} = .77\cdot[.513\cdot\frac{1}{m} + .3008(1-\frac{1}{m})]$$

where m = the regional industry multiplier.

market classes and associated market centers for each county are shown in table 3.2-29. Additional gross output generated in the region was allocated among market classes according to Chalmers' model in the following percentages:

Market class 1 - 22.55
Market class 2 - 42.16
Market class 3 - 35.29
Total - 100.00

Thus, a county classified as a secondary market center (class 2) would be allocated 64.71 percent (22.55 and 42.16) of the regioal gross output generated by a local final demand increase, and the rest (35.29 percent) would be allocated to the tertiary market center (major city in the region).

The effects of an increase in final demand do not occur immediately, but may be spread over a number of months as income recipients respond to increased income with increased purchases. To approximate the process, the increases were distributed equally over the three months following the final demand increase.

To summarize, increases in final demand were calculated by estimating the portion of construction workers expenditures and procurement which would initially accrue to local industries. Regional multipliers were then applied to obtain the increase in regional gross output. The regional gross output was allocated among counties according to their market class, and distributed over the three months following the final demand increase. Earnings ratios were then applied to determine the amount of induced personal income (the total increase in personal income is represented by induced personal income plus payrolls). Induced personal income was divided by an average monthly wage to estimate induced employment.

The induced employment was assumed to be 80 percent local and 20 percent non-local. Increases in employment would be largely the additon of one or two workers to an existing establishment. Most employers were considered to have prospective local employees available.

Transient Population

Estimates of the transient population and numbers of transient children were made by applying factors developed in other studies to non-local employment (non-local construction workers plus non-local induced employment). The 1976 study of fixed-site construction projects by the Old West Commission found that 48.9 percent of nonlocal construction workers were accompanied by their families. Families averaged 3.61 persons including the worker. Thus, the total transient population equalled 2.278 times the number of non-local workers. It also found that 21.4 percent of the transient population were children. The pipeline workers survey (Mountain West Research, 1979) found that only about 16.3 percent of workers were accompanied by families averaging 2.83 persons. The transient population was 1.298 times non-local workers, and children were 10.4 percent of the transient population.

Construction in Clallam County would be primarily at a fixed site, so, the higher factors were used there. The lower factors from the pipeline workers survey were used for all other counties.

The various estimates were made on a month-by-month basis. They were summarized by four-month intervals for presentation in the statement. See tables 3.2-33 through 3.2-36. These summary estimates are considered to fairly represent the impacts in local areas on a seasonal basis. It is considered that impacts on individual communities in the vicinity of construction activity would tend to approximate the community's share of the county population.

Population

Construction Phase

Population gains due to construction are shown in table 3.2-33 and include project-induced population gain. The table shows both maximum and average estimates for four-month periods. In order to identify potentially impacted areas, the estimates were made on the assumption that maximum construction employment at pump stations and delivery facilities would occur at the same time as maximum pipeline employment in the same vicinity. On this basis, the transient population in several counties in eastern Montana (Broadwater, Wheatland, Garfield and McCone) might have significant impacts on the local economy.

At Williston, North Dakota, the possibility of oil pipeline construction through the area at the same time as a major gas pipeline would create crowded conditions.

Operation Phase

No significant impacts on population would occur during operation phase.

Table 3.2-33 TRANSIENT POPULATION BY CONSTRUCTION PERIOD

County or State		Dec. 79-Mar. 80		Apr. 80-Jul. 80		Aug. 80-Nov. 80		Dec. 80-Mar. 81		Apr. 81-Jul. 81		Aug. 81-End	
No.	Name	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.
1	Clallam	1507	1173	818	715	771	760	675	673	722	459	69	26
2	Jefferson	91	37	105	67	14	13	13	13	15	11	2	1
3	Kitsap	0	0	0	0	0	0	0	0	0	0	0	0
61	Island	9	2	352	279	123	38	0	0	2	0	0	0
62	Whatcom	0	0	0	0	0	0	0	0	0	0	0	0
63	Skagit	14	3	248	216	183	59	1	1	3	1	0	0
64	Snohomish	21	5	396	324	356	346	306	193	16	5	0	0
7	King	276	73	410	336	373	302	284	188	33	18	6	2
8	Kittitas	300	75	500	382	577	532	5	3	7	3	0	0
9	Chelan	0	0	19	5	30	28	1	0	0	0	0	0
10	Yakima	0	0	28	12	45	41	18	11	0	0	0	0
11	Douglas	0	0	28	28	28	9	0	0	1	0	0	0
12	Grant	0	0	568	531	579	259	31	19	10	3	0	0
13	Lincoln	0	0	6	6	58	41	58	37	1	0	0	0
14	Adams	0	0	67	53	113	93	58	37	1	0	0	0
15	Spokane	0	0	284	255	453	395	383	251	17	8	0	0
16	Whitman	0	0	0	0	16	15	17	11	0	0	0	0
1	Washington		1369		3207		2927		1432		509		29
17	Kootenai	0	0	304	284	305	169	32	24	3	2	0	0
18	Benewah	0	0	59	58	59	31	12	9	1	0	0	0
19	Shoshone	0	0	68	53	430	283	385	305	9	5	0	0
2	Idaho		0		396		483		338		7		0
20	Sanders	0	0	232	216	244	200	189	138	6	2	0	0
21	Mineral	0	0	118	117	88	40	24	8	3	1	0	0
22	Lake	0	0	59	58	44	20	12	4	1	0	0	0
23	Missoula	0	0	639	602	585	534	506	187	11	7	0	0
24	Granite	0	0	30	29	12	11	0	0	1	1	0	0
25	Powell	0	0	114	98	74	68	1	0	1	1	0	0
26	Deer Lodge	0	0	12	12	12	11	0	0	0	0	0	0
27	Silver Bow	0	0	28	28	28	26	1	1	1	1	0	0
28	Lewis & Clark	0	0	264	210	577	440	11	7	10	10	0	0
29	Jefferson	0	0	31	30	41	18	0	0	1	1	0	0
30	Broadwater	0	0	195	178	204	97	0	0	3	3	0	0
31	Cascade	0	0	14	7	21	19	16	10	2	2	0	0
32	Meagher	0	0	107	106	106	27	0	0	2	2	0	0
33	Judith Basin	0	0	12	12	12	3	0	0	0	0	0	0
34	Wheatland	0	0	216	163	216	158	60	27	2	1	1	0
35	Fergus	0	0	214	110	522	385	368	166	3	2	4	1
36	Golden Valley	0	0	18	10	35	27	24	11	0	0	0	0
37	Petroleum	0	0	65	64	65	32	18	8	0	0	1	0
38	Musselshell	0	0	0	0	124	93	124	55	1	0	1	0
39	Yellowstone	0	0	13	5	15	13	8	6	2	1	0	0
40	Garfield	0	0	327	296	327	114	0	0	0	0	5	1
41	McCone	0	0	209	204	226	113	54	30	0	0	5	1
42	Custer	0	0	0	0	0	0	0	0	0	0	0	0
43	Dawson	0	0	4	2	56	42	55	31	1	1	1	0
44	Roosevelt	0	0	16	4	196	148	108	60	1	0	2	0
45	Richland	0	0	73	46	309	241	163	91	1	1	3	1
3	Montana		0		2608		2879		840		19		7
46	Williams	0	0	224	208	257	223	161	90	1	1	5	1
47	Montrail	0	0	82	80	135	69	0	0	0	0	1	0
48	Ward	0	0	264	256	351	320	352	241	9	6	8	2
49	McHenry	0	0	0	0	48	32	48	32	0	0	1	0
50	Pierce	0	0	11	11	37	27	37	25	0	0	1	0
51	Towner	0	0	37	37	29	14	11	7	0	0	1	0
52	Benson	0	0	80	79	62	37	32	22	0	0	2	1
53	Ramsey	0	0	179	163	153	98	33	23	1	0	3	1
54	Nelson	0	0	48	48	42	27	21	8	0	0	1	0
55	Grand Forks	0	0	217	210	261	252	261	105	2	1	8	2
4	N. Dakota		0		1091		1098		554		9		7
56	Polk	0	0	5	5	131	108	127	50	0	0	2	1
57	Red Lake	0	0	3	3	19	17	16	6	0	0	0	0
58	Clearwater	0	0	9	9	44	33	26	10	0	0	0	0
59	Beltrami	0	0	14	14	69	59	52	20	0	0	1	0
5	Minnesota		0		31		218		86		1		1

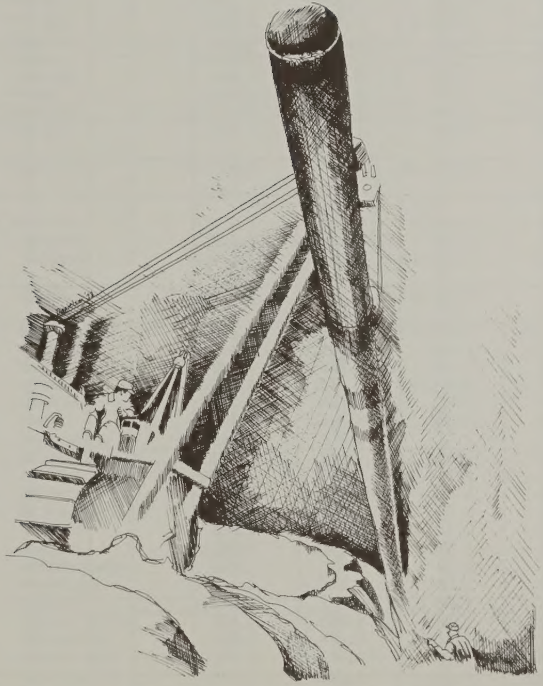
[1] See text for estimation methodology.

Table 3.2-34 CONSTRUCTION WORK FORCE BY CONSTRUCTION PERIOD

(Average Number of Workers Lodging in County)

County or State		Dec. 79-Mar. 80		Apr. 80-Jul. 80		Aug. 80-Nov. 80		Dec. 80-Mar. 81		Apr. 81-Jul. 81		Aug. 81-End	
No.	Name	Total	Local	Total	Local	Total	Local	Total	Local	Total	Local	Total	Local
1	Clallam	539	62	320	45	348	50	310	46	206	29	24	1
2	Jefferson	28	1	51	2	10	1	10	1	8	0	1	0
3	Kitsap	0	0	0	0	0	0	0	0	0	0	0	0
61	Island	8	1	223	21	57	5	0	0	2	0	0	0
62	Whatcom	0	0	0	0	0	0	0	0	0	0	0	0
63	Skagit	11	1	176	22	86	11	0	0	2	0	0	0
64	Snohomish	19	4	286	59	295	61	217	45	8	2	0	0
7	King	236	49	264	55	228	47	177	37	7	1	0	0
8	Kittitas	236	14	299	18	415	25	0	0	5	0	0	0
9	Chelan	0	0	16	2	22	2	0	0	0	0	0	0
10	Yakima	0	0	16	3	22	5	0	0	0	0	0	0
11	Douglas	0	0	22	1	14	1	0	0	0	0	0	0
12	Grant	0	0	430	44	201	21	18	2	4	0	0	0
13	Lincoln	0	0	4	0	31	1	37	1	1	0	0	0
14	Adams	0	0	40	1	71	3	37	1	1	0	0	0
15	Spokane	0	0	220	44	329	66	266	54	4	1	0	0
16	Whitman	0	0	0	0	12	1	11	1	0	0	0	0
1	Washington	695	81	2342	314	2061	290	892	152	226	31	25	2
17	Kootenai	0	0	229	25	130	14	17	2	2	0	0	0
18	Benewah	0	0	44	1	23	1	7	0	0	0	0	0
19	Shoshone	0	0	40	2	215	10	225	10	2	0	0	0
2	Idaho	0	0	313	28	367	24	249	12	5	0	0	0
20	Sanders	0	0	163	4	150	4	103	3	5	0	0	0
21	Mineral	0	0	88	1	29	1	12	0	2	0	0	0
22	Lake	0	0	44	2	15	1	6	0	1	0	0	0
23	Missoula	0	0	493	72	417	61	263	39	8	1	0	0
24	Granite	0	0	21	0	8	0	0	0	1	0	0	0
25	Powell	0	0	74	2	50	1	0	0	1	0	0	0
26	Deer Lodge	0	0	9	0	8	0	0	0	0	0	0	0
27	Silver Bow	0	0	22	2	20	2	0	0	1	0	0	0
28	Lewis & Clark	0	0	166	15	344	31	0	0	8	1	0	0
29	Jefferson	0	0	22	1	14	0	0	0	1	0	0	0
30	Broadwater	0	0	133	2	72	1	0	0	2	0	0	0
31	Cascade	0	0	0	0	0	0	0	0	0	0	0	0
32	Meagher	0	0	79	1	79	1	0	0	1	0	0	0
33	Judith Basin	0	0	9	0	9	0	0	0	0	0	0	0
34	Wheatland	0	0	122	2	117	2	39	1	2	0	1	0
35	Fergus	0	0	84	4	290	11	241	8	2	0	3	0
36	Golden Valley	0	0	8	0	20	0	16	0	0	0	0	0
37	Petroleum	0	0	48	0	23	0	12	0	0	0	1	0
38	Musselshell	0	0	0	0	69	1	82	1	0	0	1	0
39	Yellowstone	0	0	0	0	0	0	0	0	0	0	0	0
40	Garfield	0	0	220	3	111	1	0	0	0	0	4	0
41	McCone	0	0	152	2	84	1	29	0	0	0	4	0
42	Custer	0	0	0	0	0	0	0	0	0	0	0	0
43	Dawson	0	0	0	0	39	1	29	1	0	0	1	0
44	Roosevelt	0	0	12	1	112	4	59	2	0	0	1	0
45	Richland	0	0	46	1	182	6	88	3	0	0	2	0
3	Montana	0	0	1993	115	2158	130	592	32	21	2	18	0
46	Williams	0	0	159	7	168	7	88	4	0	0	2	0
47	Montrail	0	0	60	1	53	2	0	0	0	0	1	0
48	Ward	0	0	211	28	257	34	252	33	0	0	5	1
49	McHenry	0	0	0	0	32	1	32	1	0	0	1	0
50	Pierce	0	0	8	0	20	0	25	1	0	0	1	0
51	Towner	0	0	28	0	11	0	7	0	0	0	1	0
52	Benson	0	0	60	1	27	1	22	1	0	0	2	0
53	Ramsey	0	0	123	4	72	2	22	1	0	0	2	0
54	Nelson	0	0	36	1	20	0	12	0	0	0	1	0
55	Grand Forks	0	0	175	25	205	29	162	23	0	0	7	1
4	N. Dakota	0	0	859	68	857	77	564	56	0	0	15	1
56	Polk	0	0	4	0	86	7	77	6	0	0	2	0
57	Red Lake	0	0	3	0	13	0	9	0	0	0	0	0
58	Clearwater	0	0	7	0	25	1	15	0	0	0	0	0
59	Beltrami	0	0	11	1	47	4	31	2	0	0	1	0
5	Minnesota	0	0	25	2	171	11	132	8	0	0	3	0

[1] See text for estimations methodology.



Abandonment Phase

No significant impacts are expected as a result of abandonment of proposed project.

Industry and Employment

Construction Phase

Distribution of the construction work force is shown in table 3.2-34. Local workers in the construction work force represent workers living at home while working nearby.

Total employment and the local share of employment is shown in table 3.2-35. Total employment includes both construction work force and additional employment generated in the area by construction activity. The overall amount of local employment created by construction activity is shown in the table in man-years, the equivalent of so many jobs each lasting one year. Local employment generated is not considered significant.

Operation Phase

Outside the port area, operating personnel would include 38 management and system support personnel located in a headquarters office in a major city, and 42 operation and maintenance personnel in four district offices as identified in chapter one. These employment impacts would not be significant.

A 50,000 barrels per day refinery has been proposed for Grant County, Washington if the pipeline were built (Columbia Basin Herald 1979). The large construction work force required and employment of perhaps 200 workers in operations would have significant local impacts.

Abandonment Phase

Abandonment of the pipeline would probably cause the closure of the proposed refinery.

Income

Construction Phase

Personal income and gross output generated by project construction are shown in table 3.2-36. These terms are defined in the table footnotes. Increases in personal income and gross output are not considered significant impacts.

Operation Phase

Increased income from operation of the pipeline would not be significant along the pipeline route. Construction and operation of the proposed refinery in Grant County, Washington would cause significant beneficial impacts.

Abandonment Phase

Loss of crude oil supply might cause closure of the proposed refinery with a significant loss of local income.

Table 3.2-35 EMPLOYMENT BY CONSTRUCTION PERIOD[1]

(Average Number of Workers Lodging in County)

County or State		Local	Dec. 79-Mar. 80		Apr. 80-Jul. 80		Aug. 80-Nov. 80		Dec. 80-Mar. 81		Apr. 81-Jul. 81		Aug. 81-End	
No.	Name	Man-years[2]	Total	Local	Total	Local	Total	Local	Total	Local	Total	Local	Total	Local
1	Clallam	308	730	215	516	203	523	189	467	171	330	128	25	13
2	Jefferson	10	34	6	67	15	14	4	13	3	10	2	1	0
3	Kitsap	0	0	0	0	0	0	0	0	0	0	0	0	0
61	Island	29	9	2	285	71	46	17	0	0	1	0	0	0
62	Whatcom	0	0	0	0	0	0	0	0	0	0	0	0	0
63	Skagit	36	14	3	234	68	83	37	2	2	1	0	0	0
64	Snohomish	155	23	7	402	152	455	189	263	114	13	9	0	0
7	King	265	142	67	509	250	484	252	331	186	63	50	7	6
8	Kittitas	67	283	52	367	73	516	106	11	9	3	1	0	0
9	Chelan	3	0	0	19	4	29	7	2	1	0	0	0	0
10	Yakima	37	0	0	34	25	92	61	43	34	0	0	0	0
11	Douglas	2	0	0	27	5	9	2	0	0	0	0	0	0
12	Grant	83	0	0	546	138	298	98	25	10	3	1	0	0
13	Lincoln	5	0	0	5	1	38	6	35	7	1	0	0	0
14	Adams	11	0	0	49	8	98	16	36	8	1	0	0	0
15	Spokane	185	0	0	324	127	555	231	369	176	26	19	1	1
16	Whitman	2	0	0	0	0	15	3	12	4	0	0	0	0
1	Washington	1197	953	288	3370	1137	3222	1218	1593	712	452	212	33	19
17	Kootenai	58	0	0	306	87	214	73	31	13	3	1	0	0
18	Benewah	6	0	0	55	10	30	6	9	2	0	0	0	0
19	Shoshone	59	0	0	52	11	280	62	326	91	15	11	0	0
2	Idaho	123	0	0	413	108	514	141	366	106	18	13	0	0
20	Sanders	35	0	0	204	37	193	39	135	29	3	2	0	0
21	Mineral	10	0	0	109	19	39	8	8	2	1	0	0	0
22	Lake	7	0	0	57	12	23	7	5	2	0	0	0	0
23	Missoula	228	0	0	709	245	694	283	291	147	15	9	1	1
24	Granite	2	0	0	27	4	11	2	0	0	1	0	0	0
25	Powell	10	0	0	92	16	65	13	2	1	1	0	0	0
26	Deer Lodge	1	0	0	11	2	11	2	0	0	0	0	0	0
27	Silver Bow	6	0	0	29	8	29	9	2	2	1	0	0	0
28	Lewis & Clark	69	0	0	220	57	471	132	27	21	10	2	0	0
29	Jefferson	3	0	0	28	5	17	3	0	0	1	0	0	0
30	Broadwater	15	0	0	164	27	92	18	1	1	2	0	0	0
31	Cascade	38	0	0	35	28	75	60	38	31	6	5	0	0
32	Meagher	7	0	0	97	16	26	6	0	0	2	0	0	0
33	Judith Basin	1	0	0	11	2	3	1	0	0	0	0	0	0
34	Wheatland	19	0	0	150	24	148	27	26	6	1	0	0	0
35	Fergus	53	0	0	107	22	380	83	179	51	6	4	1	0
36	Golden Valley	3	0	0	9	1	25	4	10	2	0	0	0	0
37	Petroleum	6	0	0	59	10	30	6	8	1	0	0	0	0
38	Musselshell	9	0	0	0	0	86	14	54	11	1	1	0	0
39	Yellowstone	27	0	0	32	26	51	41	25	20	4	3	0	0
40	Garfield	23	0	0	273	45	111	23	1	1	0	0	1	0
41	McCone	20	0	0	189	32	108	21	29	6	0	0	1	0
42	Custer	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Dawson	12	0	0	9	8	49	17	36	12	2	2	0	0
44	Roosevelt	15	0	0	15	3	142	28	63	16	2	1	0	0
45	Richland	27	0	0	58	11	232	47	95	25	3	2	1	0
3	Montana	646	0	0	2649	640	3111	893	1027	380	35	21	8	3
46	Williams	40	0	0	200	40	223	51	95	26	3	2	1	0
47	Montrail	8	0	0	74	12	66	12	0	0	0	0	0	0
48	Ward	113	0	0	282	85	376	129	300	114	23	19	3	1
49	McHenry	3	0	0	0	0	39	6	30	5	0	0	0	0
50	Pierce	3	0	0	10	2	25	4	24	4	0	0	0	0
51	Towner	3	0	0	34	5	14	2	7	1	0	0	0	0
52	Benson	8	0	0	73	12	35	6	20	4	0	0	1	0
53	Ramsey	22	0	0	156	31	101	26	25	8	2	1	1	0
54	Nelson	4	0	0	44	7	25	4	8	1	0	0	0	0
55	Grand Forks	79	0	0	235	73	297	103	139	58	5	4	3	1
4	N. Dakota	283	0	0	1109	268	1189	343	648	222	34	27	8	2
56	Polk	12	0	0	5	1	186	22	53	14	2	1	1	0
57	Red Lake	1	0	0	3	0	15	2	6	1	0	0	0	0
58	Clearwater	2	0	0	8	1	30	5	10	2	0	0	0	0
59	Beltrami	7	0	0	13	3	58	13	22	6	1	1	0	0
5	Minnesota	22	0	0	29	5	209	42	90	23	2	2	1	0

[1] See text for estimation methodology. Estimates represent both construction workers employed in local industries as a result of increased economic activity. Estimates of local employment represent only workers residing at home and do not include local workers who would lodge in other counties (where they are treated as non-local) while working.

[2] Local man-years represent the total man-years of local employment generated by the project exclusive of local workers employed elsewhere.

TABLE 3.2-36 PERSONAL INCOME AND GROSS OUTPUT 1/
(In Thousands of Dollars)

No.	County or State Name	Personal Income Total	Personal Income Max. Rate/Yr	Gross Output Total	Gross Output Max. Rate/Yr.
1	Clallam	28,809.8	32,359.6	15,782.4	15,699.1
2	Jefferson	1,683.2	3,774.0	581.3	1,296.8
3	Kitsap	0.0	0.0	0.0	0.0
61	Island	3,936.4	13,123.6	1,461.4	4,393.2
62	Whatcom	0.0	0.0	0.0	0.0
63	Skagit	3,486.0	9,355.4	1,822.7	4,569.0
64	Snohomish	11,891.8	16,355.7	7,115.2	10,035.5
7	King	12,852.8	17,027.0	14,943.8	16,105.2
8	Kittitas	11,317.8	19,706.3	3,497.5	6,045.1
9	Chelan	393.2	1,079.4	162.9	428.5
10	Yakima	927.3	1,985.3	2,445.4	4,421.4
11	Douglas	404.4	921.2	127.5	290.4
12	Grant	9,355.6	20,032.7	4,153.0	8,753.9
13	Lincoln	888.5	1,840.0	275.3	570.1
14	Adams	,954.1	3,602.5	615.7	1,069.5
15	Spokane	11,883.5	17,637.0	9,248.1	12,018.2
16	Whitman	250.3	570.1	109.0	248.4
1	Washington	100,034.6		62,341.2	
17	Kootenai	5,471.2	10,451.4	2,526.0	4,811.9
18	Benewah	1,026.8	1,839.5	317.1	568.2
19	Shoshone	6,912.4	13,707.6	2,917.7	5,36..4
2	Idaho	13,410.4		5,760.9	
20	Sanders	5,625.6	7,578.8	1,737.6	2,227.6
21	Mineral	1,584.7	3,391.0	487.8	1,042.6
22	Lake	815.2	1,744.1	340.5	726.9
23	Missoula	14,745.8	21,112.2	9,704.9	13,686.5
24	Granite	378.7	843.6	116.4	243.2
25	Powell	1,602.2	3,295.2	502.7	955.1
26	Deer Lodge	216.7	339.6	67.8	106.2
27	Silver Bow	564.7	884.7	266.2	417.1
28	Lewis & Clark	6,797.0	17,788.1	2,957.4	6,155.0
29	Jefferson	459.9	1,177.9	137.0	336.7
30	Broadwater	2,621.3	5,828.5	782.4	1,723.2
31	Cascade	487.2	827.9	2,076.5	3,528.2
32	Meagher	1,266.6	3,041.1	374.5	898.4
33	Judith Basin	140.7	337.9	41.6	99.9
34	Wheatland	3,371.2	6,351.2	980.6	1,783.3
35	Fergus	6,672.6	15,784.5	2,557.8	4,711.4
36	Golden Valley	462.2	1,045.4	135.7	273.2
37	Petroleum	933.8	1,859.3	292.8	547.5
38	Musselshell	1,419.0	3,557.5	433.1	1,085.7
39	Yellowstone	350.9	580.5	1,490.8	2,466.4
40	Garfield	5,933.6	9,374.2	1,198.5	2,827.9
41	McCone	3,358.3	6,549.3	1,013.4	1,937.2
42	Custer	0.0	0.0	0.0	0.0
43	Dawson	762.1	1,676.4	628.8	998.1
44	Roosevelt	2,157.1	5,997.7	725.2	1,709.7
45	Richland	3,773.3	9,317.2	1,301.9	2,780.2
3	Montana	64,560.5		30,351.9	
46	Williams	4,917.4	7,401.2	1,772.5	2,538.9
47	Montrail	1,333.5	3,661.6	374.7	963.4
48	Ward	8,050.1	10,329.8	4,385.7	5,878.5
49	McHenry	551.3	1,234.7	161.4	261.6
50	Pierce	537.8	960.1	157.0	280.2
51	Towner	504.5	960.1	147.0	279.5
52	Benson	1,186.6	2,058.2	347.6	602.5
53	Ramsey	2,444.3	4,628.9	1,003.5	1,836.0
54	Nelson	709.6	1,234.5	207.0	359.7
55	Grand Forks	5,631.7	7,717.2	2,964.1	4,003.1
4	N. Dakota	25,866.8		11,520.4	
56	Polk	1,476.0	3,574.2	557.3	1,334.1
57	Red Lake	209.8	497.7	59.4	130.2
58	Clearwater	402.0	1,193.8	112.9	276.0
59	Beltrami	774.3	1,987.7	301.5	605.3
5	Minnesota	2,862.0		1,031.0	

1/ See text for estimation methodology. Personal income reresents construction pay rolls plus additional earnings (wages and profits) of persons in local industry. Gross output is local gross business income, exclusive of cost of goods sold by trade industries, generated by local expenditures of construction workers and contractors. Gross output is often smaller than personal income because construction workers' local expenditures are expected to be small. Totals represent the sum of amounts over the entire construction period. The maximum rate per year is the highest monthly amount multiplied by twelve.

Fiscal Conditions

Construction Phase

Major tax revenues in the form of sales and income taxes would be generated during initial construction phase by construction and associated expenditures as shown in table 3.2-37. Sales tax would be applied to the gross contract value, with local incidence based on place of work rather than place of purchase (Washington Department of Revenue 1978).

The Washington local sales tax rate is 0.5 percent for all impacted counties with the exception of King, which imposes a 0.8 percent sales tax. State sales tax rates range from 3 percent for Idaho and North Dakota to 4.6 percent for Washington. Montana does not impose a state sales tax. Sales taxes outside of Washington would

TABLE 3.2-37 MAJOR TAX REVENUES, INITIAL CONSTRUCTION PHASE

(Thousands of Dollars)

				Construction Expenditures			Personal Income		
	Sales Taxes	Income Taxes	Total Tax Revenues	Value[1/]	Percent Taxable[2/]	Sales Tax Rate[2/]	Amount[3/]	Effective Rate [4/] Sales	Income
Local Taxes[6/]									
Clallam	$ 782	----	$ 782	$ 147,487	100	0.5	$ 28,810	.156	----
Jefferson	160	----	160	31,386	100	0.5	1,683	.156	----
Island	195	----	195	37,683	100	0.5	3,936	.156	----
Skagit	5	----	5	----	100	0.5	3,486	.156	----
Snohomish	185	----	185	33,315	100	0.5	11,891	.156	----
King	294	----	294	32,679	100	0.8	12,853	.250	----
Kittitas	282	----	282	52,804	100	0.5	11,318	.156	----
Chelan	1	----	1	----	100	0.5	393	.156	----
Yakima	1	----	1	----	100	0.5	927	.156	----
Douglas	1	----	1	----	100	0.5	404	.156	----
Grant	203	----	203	37,709	100	0.5	9,356	.156	----
Lincoln	124	----	124	24,519	100	0.5	888	.156	----
Adams	69	----	69	13,196	100	0.5	1,954	.156	----
Spokane	154	----	154	27,028	100	0.5	11,883	.156	----
Whitman	*		*	----	100	0.5	250	.156	----
Total Local	2,456		2,456						
State Taxes									
Washington	22,223	----	22223	437,806	100	4.6	100,035	2.083	----
Idaho	822	300	1122	54,055	40	3.0	13,410	1.293	2.24
Montana	----	5352	5352	418,627	---	---	64,560	----	8.29[5/]
North Dakota	2903	450	3353	214,389	40	3.0	25,867	1.278	1.74
Minnesota	794	99	894	46,513	40	4.0	2,862	1.753	3.47[5/]
Total State	26,742	6,201	32,943						

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*Less than $ 500

[1/] Derived from Table 3.2-38 by factoring values to omit elements of construction costs not subject to sales tax. These items include sales and use taxes, environmental studies, and construction management.

[2/] Based on information from respective state revenue agencies.

[3/] County estimates derived from Table 3.2-36. State estimates similarly computed as total construction payrolls plus earnings generated by expenditures of construction workers and local construction procurement.

[4/] Effective sales tax rates represent statutory rates applied to local (or instate) consumption expenditures as a proportion of income. Effective income tax rates furnished by state authorities except as noted.

[5/] Based on 1976 tax collections as a percent of personal income.

[6/] Represents local sales taxes in Washington State.

apply only to an estimated 40 percent of construction costs. Local governments outside of Washington would not be directly compensated for expenditures incurred in the construction phase, since none impose major taxes directly affected by construction activity. In addition to the sales tax directly on construction value, additional sales tax reviews would be derived from a portion of personal income generated during the construction period. Apportionment of personal income subject to sales tax was based on estimates of expenditures. The portion of expenditure not subject to tax was considered offset by business expenditures subject to tax and not part of personal income. Expenditures were estimated as 54.8 percent of local (or in state) workers' income, and 27.4 percent of non-local (or out-of-state) workers' income (see Induced Income and Employment). Personal income (table 3.2-36) for the local areas affected (Washington counties) was divided into local and non-local components in proportion to local and non-local construction employment in the state (local, 3,473 man-months, non-local, 21,442). For the affected states, income was divided in proportion to in-state and out-of-state construction employment. In-state and out-of-state man-months, respectively, for each state are: Washington, 16,263 and 8,652; Idaho, 2,135 and 1,593; North Dakota, 4,760 and 3,827; and Minnesota, 586 and 391.

Based on construction cost estimates plus additional sales tax from construction generated personal income, approximately $29 million would be paid in state and local sales taxes during the construction period. Over $22 million, would go to the state of Washington. Clallam County would receive an estimated $782,000. Idaho, Montana, North Dakota, and Minnesota would gain about $6.2 million from state income taxes generated during construction. Montana would receive about $5.35 million.

Local government expenditures would generally be minor. Significant impacts on local budgets would occur if unreimbursed road repair costs were substantially in excess of increased revenues. These costs cannot be quantified because their magnitude would be affected by enforcement of road regulations, collection of reimbursable amounts, and weather conditions.

State government expenditures would be minor in comparison with tax receipts. Net gains in revenues are not large enough to be considered significant.

Operation Phase

Property taxes accruing to each county in the first year of operation for both the initial and ultimate phases are shown in table 3.2-38. Estimates are based on average levies in each county. Assessment values are based on construction costs for the pipeline and the facilities in each county along the route. Once in operation, property tax assessments would normally be based on income (i.e., earnings on investment), and would be subject to depreciation. Assessment values and taxes might average only half the initial value over the life of the project.

Montana state and local governments would receive $13.3 million in property tax payments in the first year of operation or one-half the estimated $25.2 million in property tax revenues to be generated by the entire project. Only those counties in which pipeline property was located would benefit directly from local property taxes.

Counties which would have an increase of ten percent or more in total assessment value in the first year of operation are considered to have a significant beneficial impact and are identified by asterisks in table 3.2-38.

Market Area

Construction Phase

No significant impacts on the market area would occur as a result of construction.

Operation Phase

Increased supplies of crude oil would enable refineries in the northern tier states to continue operations. Petroleum product prices in the affected states would be reduced. If the proposed supply route were more economical than existing routes, a competitive readjustment of crude supply costs would benefit consumers in the market areas. An additional supply route would provide more system flexibility and reduced likelihood of oil shortages. Access to additional domestic oil sources would also reduce supply uncertainties. Improved access to the market area for ANS crude would increase the price received by ANS producers and the royalties to Alaska. The significance of these beneficial impacts has not been determined.

Abandonment Phase

Abandonment of the project could have significant adverse impacts in the market area. The probable loss of crude oil supply would result in higher energy costs and reduced energy use. There would be an accompanying loss of jobs and reduced level of economic welfare in the market area.

SOCIAL CONDITIONS

Infrastructure

Construction Phase

The proposed pipeline system would cause minimal impacts on the infrastructure of rural communities. The greatest impact would be on housing; severity would vary depending on the time of year construction workers are in the community. It is anticipated that workers would require housing for 2 to 3 months at a time, and then move to another community. Adequate accommodations may be available during winter months; housing would be scare during summer months.

Local police and fire protection services would be strained by construction workers. An increase in minor civil incidents might occur because of different values and attitudes of the construction workers than those held by community members. The antagonism would quickly dissipate as workers move to a new location. Construction accidents would place a minor burden on volunteer fire departments.

All other elements of the community infrastructure would not be impacted by construction workers.

Operation Phase

Infrastructure of rural communities would not normally be impacted. However, if a fire or explosion occurred at a pump station, or a major oil spill occurred, local

Table 3.2-38 PROPERTY TAXES, INITIAL AND ULTIMATE PHASES

(Thousands of Dollars, Estimates for first year of operation without allowance for depreciation in subsequent years.)

County and State	Pipeline Mileage	Initial Phase (709,000 bpd)							Ultimate Phase (933,000 bpd)			
		Pipeline Value	Facility Value	Total Value	Assess Ratio Percent	Average Levy Mills	Assessed Value	Property Tax	Additional Value	Total Value	Assessed Value	Property Tax
Washington	(367)	265,074	166,439	431,513	—	—	351,732	5,520	29,996	459,494	373,605	5,862
*Clallam	17	12,279	143,199	155,478	77.5	15.49	120,495	1,866	26,127	181,511	140,671	2,178
Jefferson	10	7,223	—	7,223	80.2	14.06	5,793	81	—	7,168	5,749	81
Island	28	20,224	—	20,224	71.3	14.16	14,419	204	—	20,070	14,310	203
Snohomish	48	34,669	3,320	37,989	86.2	16.36	32,746	536	541	38,266	32,986	540
King	42	30,335	6,640	36,975	90.2	17.45	33,352	582	914	37,659	33,968	593
*Kittitas	79	57,059	3,320	60,379	88.2	14.54	53,255	774	895	60,841	53,661	780
Grant	50	36,114	3,320	39,434	73.0	16.33	28,786	470	—	39,159	28,586	467
Lincoln	39	28,169	—	28,169	95.2	14.56	26,816	390	—	27,954	26,613	387
Adams	16	11,556	3,320	14,876	82.8	13.78	12,318	170	940	15,728	13,023	179
Spokane	38	27,446	3,320	30,766	77.2	18.84	23,752	447	580	31,138	24,038	453
Idaho	(76)	54,893	6,640	61,533	—	—	13,169	1,344	887	62,002	13,268	1,355
*Benewah[1]	21	15,168	—	15,168	21.4	104.23	3,639	379	—	15,052	3,666	382
Kootenai[1]	22	15,890	3,320	19,210	21.4	121.81	3,812	464	323	19,412	3,841	468
Shoshone[1]	33	23,835	3,320	27,155	21.4	87.64	5,718	501	564	27,538	5,761	505
Montana	(631)	426,785	34,495	461,280			71,235	13,315	6,646	466,973	71,649	13,378
*Sanders	63	45,503	3,320	48,823		167.01	7,564	1,263	1,219	49,696	7,613	1,271
Missoula	73	52,726	3,320	56,046		248.37	8,720	2,166	867	56,512	8,730	2,168
Granite	14	10,112	—	10,112		272.59	1,618	441	—	10,035	1,606	438
*Powell	43	31,058	3,320	34,378	See	196.36	5,253	1,031	467	34,609	5,255	1,032
*Lewis & Clark	32	23,113	—	23,113		301.74	3,698	1,116	—	22,937	3,670	1,107
*Jefferson	1	722	—	722	note	242.84	116	28	—	717	115	28
*Broadwater	44	31,780	3,320	35,100		185.60	5,369	996	1,169	36,027	5,430	1,008
*Meagher	43	31,058	—	31,058	2	179.27	4,969	891	—	30,822	4,931	884
*Wheatland (42)[3]	43	30,961	10,419	41,380		185.28	5,845	1,083	401	41,553	5,842	1,082
*Golden Valley	19	11,888	—	11,888	below	160.72	1,902	306	—	11,940	1,910	307
*Musselshell	17	10,637	—	10,637		119.62	1,702	204	—	10,683	1,709	204
Fergus	2	1,251	—	1,251		204.20	200	41	—	1,257	201	41
*Petroleum	37	23,151	—	23,151		127.59	3,704	473	—	23,252	3,720	475
*Garfield	84	52,558	1,775	54,333		164.70	8,561	1,410	1,659	56,222	8,740	1,439
*McCone	55	34,413	—	34,413		128.67	5,506	708	—	34,564	5,530	712
*Dawson	2	1,251	—	1,251		260.81	200	52	—	1,257	201	52
*Richland (14)[3]	56	32,880	9,023	41,903		174.21	6,032	1,051	864	43,143	6,166	1,074
*Roosevelt	3	1,723	—	1,723		201.12	276	55	—	1,747	280	56
North Dakota	(342)	192,445	10,185	202,630			17,028	3,430	3,069	208,471	17,153	3,524
*Williams (57)[3]	61	34,977	7,650	42,627	8.4	188.10	3,581	674	270	43,387	3,645	686
*Montrail	42	23,536	—	23,536	8.4	186.38	1,977	368	—	23,877	2,006	374
Ward	42	23,536	—	23,536	8.4	19.29	1,979	434	—	23,877	2,006	440
*McHenry	37	20,734	—	20,734	8.4	182.38	1,744	318	2,535	23,570	1,980	361
*Pierce	18	10,087	—	10,087	8.4	183.88	848	156	—	10,233	860	158
*Benson	31	17,372	—	17,372	8.4	188.11	1,461	275	—	17,624	1,480	278
*Ramsey	41	22,976	2,535	25,511	8.4	210.33	2,143	451	264	26,108	2,193	461
*Nelson	26	14,570	—	14,570	8.4	189.96	1,224	232	—	14,781	1,242	236
Grand Forks	44	24,657	—	24,657	8.4	252.06	2,071	522	—	25,014	2,101	530
Minnesota	(75)	42,029	1,701	43,730			14,562	1,557	2,535	46,875	15,609	1,667
*Polk	54	30,261	—	30,261	33.3	104.26	10,077	1,051	2,535	33,235	11,067	1,154
*Red Lake	13	7,285	—	7,285	33.3	121.93	2,426	296	—	7,391	2,461	300
Clearwater	8	4,483	1,701	6,184	33.3	102.16	2,059	210	—	6,249	2,081	213
Total	1,491	981,226	219,460	1,200,685	—	—	467,726	25,166	43,133	1,243,815	491,284	25,786

Source: Washington Department of Revenue, Idaho Department of Revenue and Taxation, Montana Department of Revenue, North Dakota Office of State Tax Commissioner, Minnesota Department of Revenue.

*Significant beneficial impact. Increase in property tax base greater than 10 percent of existing level in first year of operation.

Note: Property taxes were calculated on the basis of estimated construction costs. Major facilities including pump stations were assigned to the counties in which they were located. Individual pump station values were estimated at $3,320,000 on 42-inch line, and $2,535,000 on 40-inch line (except the station in Garfield County, Montana which would be initially only partially constructed). Additional value for existing pump stations in the ultimate phase was estimated in proportion to the addition to horsepower requirements.

Pipeline value (totaling $981,222,000 exclusive of major facility costs) was distributed in proportion to a volume-mile distribution. Based on expected volumes and number of miles transported, allocation factors representing the pipeline value per mile were developed by dividing the distributed pipeline by the number of miles involved. The following values per mile were derived:

		Initial Phase		Ultimate Phase	
Delivery Point	**Miles**	**Volume**	**Value/mile**	**Volume**	**Value/mile**
Glacier (Wheatland Co., MT)	798	709	$722,270	933	$716,780
Western Crude (Richland Co., MT)	231	614	625,690	818	628,430
Amoco (Williams Co., ND)	102	564	574,300	758	582,340
Clearbrook (Clearwater Co., MN)	360	550	560,390	740	568,510
	1,491				

[1] In Idaho, the total assessed value of all pipeline property in the state was distributed among counties in proportion to mileage in accordance with state utility valuation procedures.

[2] In Montana, assessed values were calculated separately for facility value (situs property) at a common local assessment ratio of 8.55 percent, and for pipeline property at the state utility ratio of 16.0 percent.

[3] Figure in parentheses is mileage from western boundary of county to delivery point.

volunteer fire fighters and police would be called for assistance. This would temporarily detract from their ability to respond to other emergency calls.

Solid waste services would also not incur a significant impact except in the case of a large oil spill. Oily wastes would require special handling and might require separate disposal. If the existing landfill is satisfactory for disposal of oily wastes, management plans for operation of the site woud need to be substantially modified to accommodate any large quantity of oily waste material.

Abandonment Phase

No impacts on infrastructure are anticipated.

Social Well-Being and Quality of Life

Construction Phase

No significant beneficial or adverse impacts would occur on the indicators of social well-being and quality of life. During the construction phase those residents living near or making involuntary contact with pipeline activities would experience problems of varying intensity, but only for relatively short periods of time. Residents in smaller towns and communities would encounter some disruption in their life style patterns. Employment opportunities for local residents would be limited and per capita income benefits would be minimal.

Operation Phase

During operation of the proposed project no significant beneficial or adverse impacts would occur.

In forested areas the pipeline corridor would have a negative effect on the aesthetic setting. A decision at the federal level to approve the proposal would have a negative effect on attitudes favoring local community decision-making rights and powers. However, there would be no significant adverse impacts.

Abandonment Phase

Abandonment would not cause any significant impacts to the social well-being and quality of life of residents along the proposed pipeline route.

Native Americans

Infrastructure

Since the proposed pipeline system route would not affect reservation housing, schools, utility systems, or medical care and police/fire protection services, there would be no adverse impacts.

Social Well-Being and Quality of Life

Construction and operation of the proposed pipeline system would introduce the potential of oil leakage, spills, and increased river sedimentation. These could affect operation of the tribal fish enterprises. The proposal might have adverse impacts on the four tribal groups in Western Washington. There wold be no significant adverse impacts on the social well-being indicators that pertain to the Coeur d'Alene Reservation.

At the present time the proposed project is opposed by individual tribes as well as the Point No Point Treaty Association and the Northwest Intertribal Fisheries Commission. A decision to approve the proposal would have adverse affects on efforts to ease tensions in Indian/non-Indian governmental relationships.

There would be no significant impacts to social well-being or quality of life due to project abandonment.

4

MITIGATING MEASURES

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MITIGATING MEASURES NOT INCLUDED IN THE PROPOSAL
(Proposal of the Northern Tier Pipeline Company)

Measures which could further reduce the impacts identified in chapter 3 are addressed in this chapter as possible mitigating measures.

Most proposed impact reducing measures are design features, construction-reclamation methods, or operating procedures, which are discussed in chapter 1 and were considered in the analysis of impacts in chapter 3. Federal and state agencies and private landowners could require additional measures as special conditions to permits and easements.

Available information on the proposal addresses the pipeline route in terms of a 2-mile wide corridor. The port and onshore storage facilities as well as the pipeline system are addressed in terms of preliminary design criteria. Federal, state, and local agencies require more specific information on proposed locations, design of system components, construction schedules and methods, reclamation methods, and operating procedures to determine what mitigating measures would be required. Private landowners also need more site specific details in order to determine measures they would require as easement provisions.

The possible mitigating measures that follow address only the significant impacts identified in chapter 3. They are considered reasonable, enforceable measures which might be included as terms and conditions to permits, easements, or right-of-way grants issued by private individuals, local, state or federal agencies should the NTPC proposal be approved.

Green Point, Washington Bureau of Land Management

TABLE 4-1 POSSIBLE MITIGATING MEASURES
Port and Onshore Storage Facility

Mitigating Measure	Effectiveness	Environmental Component
Require tankers to have a segregated ballast capability of at least 20 percent of deadweight tonnage	100 percent effective in eliminating hydrocarbon emissions from ballasting operations	Air Quality
Require a pressure relief setting of at least 1.5 pounds per square inch on all cargo tanks	100 percent effective in eliminating hydrocarbon emissions from venting of emptied cargo tanks	Air Quality
Prohibit submarine pipeline construction activity at night	100 percent effective in keeping nighttime noise levels below Washington State standards and preventing annoyance to nearby residents	Noise
Reroute pipeline to follow gentler slopes and avoid bluff at Green Point	85-90 percent effective in preventing failure and possible pipe rupture	Topography Geology
Employ vessel traffic service	Effectiveness in decreasing the risk of tanker accidents and oil spills not determined	Marine Resources
Designate "no anchorage zone" in vicinity of submarine pipeline	Nearly 100 percent effective in decreasing chance of damage to submarine pipeline from anchor dragging and reducing the risk of pipe rupture and oil spill	Marine Resources
Require tug escort of tankers from Cape Flattery to Port Angeles	Effectiveness in reducing tanker grounding and decreasing risk of oil spill not determined	Marine Resources
Require U.S. Coast Guard/ Washington State approved pilots to accompany tankers from Cape Flattery to Port Angeles	Effectiveness in reducing grounding and collisions and decreasing risk of oil spill not determined	Marine Resources

TABLE 4-1 (Port and Onshore Storage Facility, Continued)

Mitigating Measure	Effectiveness	Environmental Component
Schedule submarine pipeline dredging to avoid sensitive period during surf smelt spawning run	50 percent effective in eliminating losses to surf smelt population resulting in an insignificant loss	Marine Resources
Establish minimum separation distances between unloading tankers and other vessels	Nearly 100 percent effective in eliminating risk of collisions, fire, explosion, and oil spills for large commercial vessels. Somewhat less effective for small recreational craft	Marine Resources Recreation
Relocate marina and boat ramp prior to construction of port facility	100 percent effective in preventing loss of use of these facilities	Recreation
Restrict port operations during annual salmon derby days	Effectiveness in reducing parking congestion on Ediz Hook and boat traffic congestion in harbor not determined	Recreation
Schedule tanker arrivals to reduce queueing time in Port Angeles harbor	Effectiveness in reducing vessel traffic congestion in Port Angeles harbor not determined	Transportation
Require bussing and car-pooling of construction workers to Green Point and Ediz Hook construction sites	Effectiveness in reducing traffic congestion in Port Angeles and Green Point area and possibly Sequim not determined	Transportation
Require relocation of the V.O.R. Air Navigation site prior to construction of the port facility	100 percent effective in preventing temporary loss of an air navigation aid	Transportation
Require U.S. Coast Guard approval of outdoor lighting at the port facility	100 percent effective in eliminating potentially hazardous lighting conditions which could interfere with operations at the U.S. Coast Guard Station	Transportation

TABLE 4-1 (Port and Onshore Storage Facility, Continued)

Mitigating Measure	Effectiveness	Environmental Component
Avoid and only when necessary excavate for data recovery cultural and paleontological resources identified during pre-construction and construction surveys	100 percent effective in providing opportunity to avoid destruction of some cultural resources and to recover data from others	Cultural
Require prepayment of property taxes	Nearly 100 percent effective in eliminating local budget deficits	Economic
Require payment of incremental electrical power costs	100 percent effective in preventing increased electrical power costs to other customers which would be caused by the project	Utilities
Implementation of a road management program by local road authorities which would monitor road use and require reimbursement for costs of road repair	Could be significantly effective in collecting the reimbursable costs of road repair	Economics

Inner harbor at Port Angeles during the 1975 Salmon Derby

The Port Angeles Daily News

TABLE 4-2 POSSIBLE MITIGATING MEASURES
Pipeline System

Mitigating Measure	Effectiveness	Environmental Component
Locate mainline stations at least 2500 feet from the nearest noise sensitive receptors	100 percent effective in preventing a noticeable increase in noise levels at these locations and preventing possible annoyance to residents	Noise
Reroute pipeline to avoid unstable and potentially unstable slopes such as those at Brown Point, Partridge Point and Seigal Creek	90-95 percent effective in preventing slope failure and accidents during construction and pipe rupture and oil spills during operation	Topography Geology
Use stronger pipe in unstable and potentially unstable areas to absorb stress caused by slope failure and prevent pipe rupture	Effectiveness in preventing slope failure and possible accidents during construction and pipe rupture during operation cannot be determined	Topography Geology
Reroute pipeline to avoid liquefaction zones	100 percent effective in preventing pipe rupture caused by liquefaction	Topography Geology
Use stronger pipe in liquefaction zones	Effectiveness in preventing pipe rupture caused by liquefaction cannot be determined	Topography Geology
Water sprinkle disturbed soils in rural areas during construction	50-90 percent effective in eliminating soil losses from fugitive dust. Fugitive dust soil losses 225 lbs/acre without mitigation, 22 to 112 lbs/acre with mitigation	Soils
Limit time, rate and location of test water withdrawal and discharge	Nearly 100 percent effective in eliminating fish mortalities, meeting minimum flow requirements, preventing hydraulic scouring, and insuring quality irrigation water	Aquatic Resources
Place block valves at stream crossings in addition to those specified	100 percent effective in reducing amount of oil entering streams in the event of an oil spill. Percent of reduction different at each stream crossing	Aquatic Resources
Clear flood debris from streams at stream crossings	100 percent effective in reducing accelerated scour and potential pipe rupture	Aquatic Resources
Divert flow around construction area in streams	Effectiveness in reducing sediment concentration and siltation in streams not determined but expected to be significant	Aquatic Resources
Periodic sampling of existing and/or new test wells near pipeline	100 percent effective in providing early warning of oil contaminated water near major aquifers	Aquatic Resources
Reroute submarine pipeline around valuable clam and oyster beds	100 percent effective in eliminating loss of valuable clam and oyster beds	Marine Resources
Establish vegetative screen where right-of-way crosses trails and scenic travelways	Nearly 100 percent effective in eliminating visual intrusion of right-of-way depending on vegetation used and terrain	Visual Resources Recreation
Erect physical barrier to vehicles on pipeline access roads and on national trails	Effectiveness in preventing recreational vehicles from entering right-of-way and disturbing other recreationists and contributing to soil erosion not determined	Recreation Soils
Designate special camping areas for construction crews	Effectiveness of reducing demands on camping facilities and housing not determined	Recreation Social

TABLE 4-2 (Pipeline System, Continued)

Mitigating Measure	Effectiveness	Environmental Component
Reroute pipeline to avoid subsurface drain tile in agricultural areas or modifiy existing drainage systems encountered to insure proper drainage	100 percent effective in preventing drainage problems on agricultural lands	Land Use
Reroute pipeline to avoid the Oakville Prairie in North Dakota	100 percent effective in eliminating impacts to scientific study area	Land Use
Require use of aerial, cable, or other special equipment and methods to transport material and equipment in areas where extensive road construction would be undesirable	Effectiveness in eliminating extensive access road construction or modification not determined	Transportation Land Use
Construct temporary camps for construction workers	Effectiveness in reducing demands on local housing not determined	Social Economic
Provide field medical personnel during construction	Effectiveness to reducing demands on local medical personnel not determined	Social
Require barge or onshore storage of streambed spoils	Effectiveness in reducing sediment concentration and siltation not determined but expected to be significant	Aquatic Resources
Require appropriate agency approval for location and design of access roads	Effectiveness in reducing damage to existing roads and assuring compliance with applicable policies not determined	Transportation
Locate borrow areas away from roads and public use areas	Nearly 100 percent effective in eliminating public exposure	Visual

TABLE 4-2 (Pipeline System, Continued)

Mitigating Measure	Effectiveness	Environmental Component
Avoid and only when necessary excavate for data recovery cultural and paleontological resources identified during pre-construction and construction surveys	100 percent effective in providing opportunity to avoid destruction of some cultural resources and to recover data from others	Cultural
Avoid threatened and endangered plant and animal species identified during pre-construction and construction surveys	100 percent effective in providing the opportunity to avoid or reduce damage, destruction, and disturbance to threatened and endangered species by rerouting pipeline or rescheduling construction activities	Vegetation Wildlife
Maintain a buffer zone around bald eagle nest sites during construction	Effectiveness in reducing disturbance to bald eagles and assuring against possible nest abandonment and lost eagle production for one season not determined	Wildlife
Revegetate corridor with plant species beneficial to wildlife, particularly in areas where valuable summer or winter food species would be removed	100 percent effective in assuring against loss of valuable food species for wildlife	Wildlife
Schedule construction activities to avoid periods of sensitivity which could reduce wildlife populations, particularily bald eagles	100 percent effective in eliminating losses to wildlife populations	Wildlife

TABLE 4-2 (Pipeline System, Continued)

Mitigating Measure	Effectiveness	Environmental Component
Require payment of incremental electrical power costs	100 percent effective in preventing increased electrical power costs to other customers which would be caused by the project	Utilities
Implementation of a road management program by local road authorities which would monitor road use and require reimbursement for cost of road repair	Could be significantly effective in collecting the reimburseable costs of road repair	Economics
Require that construction activity in the Williston, North Dakota area not be conducted concurrently with construction of the Northern Border Gas Pipeline	100 percent effective in reducing demands on housing and community services to an acceptable level	Social

Bureau of Land Management

5 UNAVOIDABLE ADVERSE IMPACTS

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ANY ADVERSE IMPACTS THAT CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

(Proposal of the Northern Tier Pipeline Company)

This chapter identifies, summarizes, and where possible, quantifies only the significant unavoidable adverse impacts. These include impacts which are not amenable to mitigation, hence they are unavoidable and would occur if the proposal is implemented. Other impacts are susceptible to varying degrees of mitigation. These impacts are described here with the assumption that the possible mitigating measures identified in chapter 4 would be implemented. To the extent that they would not be implemented, the significant adverse impacts would be as described in chapter 3.

The impact descriptions in this chapter assume removal of project facilities during abandonment except for structures at the port, submarine pipelines, and pipeline crossings of streams, railroads, and highways (see chapter 1).

5.1 Port and Onshore Storage Facilities

OIL SPILL, FIRE, AND EXPLOSION RISK

The risk of an oil spill, fire, or explosion would be unavoidable if the project were implemented. The actual events of an oil spill, fire, or explosion may or may not occur according to the statistical analysis presented in chapter 3, but the risk of their occurrence, along with the possible damage incurred, would persist for the life of the project. Potential frequencies and magnitudes of these events are described in chapter 3.

AIR QUALITY

Fugitive dust emissions at the site of the proposed onshore storage facility would range between 0.5 and 2.7 tons per day and could be a nuisance in the construction area. Emissions would be intermittent over an 18-month period.

Tanker stack emissions during project operation could cause sulfur dioxide concentrations at the Olympic National Park Visitors Center to exceed the 24-hour Class I incremental standard up to 10 times per year. The 3-hour Class I incremental standard for sulfur dioxide could be exceeded up to 14 times per year.

The maximum allowable Class II incremental standard for 24-hour average sulfur dioxide concentrations could be exceeded once or twice a year over the Port Angeles area.

There might be infrequent periods of noticeably reduced visibility in the Port Angeles area and from viewpoints within the Olympic National Park. The reduction in visual range for the highest anticipated emission rate would be about 7 percent, the increase in air pollutants caused by the proposal are not anticipated to cause any significant public health hazard.

During abandonment, removal of structures at the onshore storage facility could cause fugitive dust emissions to reach nuisance levels similar to those incurred during construction.

NOISE

During construction, pile driving at the proposed port facility would cause daytime equivalent noise levels of 82 to 83 dBA at the public recreation area on Ediz Hook, which would discourage visitor use. Noise levels would also be noticeable at the U.S. Coast Guard Station.

Trenching and pile driving near the bluff at Green Point would cause daytime noise levels of 65 to 70 dBA over about a 3-month period at nearby residences. This would hamper outdoor communications and could annoy residents.

Construction equipment at the onshore storage facility would occasionally cause daytime average noise levels of 60 to 70 dBA at 10 residences directly west of the site and noise levels of 50 to 60 dBA at an additional 20 residences over an 18-month period. These noise levels would be annoying to residents.

Electric motors at the pump station would cause a nighttime noise level of 47 dBA (equal to the Washington state noise standard) at residences immediately west of the site. The increase in noise levels above existing levels would be significant and residents might be annoyed.

During abandonment, dismantling of the onshore storage facility at Green Point would cause unavoidable noise impacts at nearby residences. The increased noise might be annoying to residents.

TOPOGRAPHY AND GEOLOGY

The port and onshore storage facilities could be damaged by an earthquake exceeding design criteria causing an oil spill, fire, or explosion. Thus, assuming construction to seismic risk zone 3 standards, an earthquake of VII+ intensity (Modified Mercalli Scale) could cause the impacts described. The likelihood of such an earthquake occurring during the life of the project cannot be predicted.

The submarine pipelines between the port and onshore storage facility could be ruptured by an earthquake. This could cause an oil spill of up to 5,000 barrels from each of the two pipelines.

SOILS

During construction at the onshore storage facility, soil loss from dust would range from 6 to 28 tons per month of construction. This would total 108 to 504 tons for the 18-month construction period. Soil loss from water erosion would be in the range of 70 to 600 tons. Significant soil loss would occur from fugitive dust and water erosion. Soil productivity would be lost from much of the 140-acre site for the life of the project.

During abandonment, if structures were removed, soil losses would occur at about the same rate as during construction.

AQUATIC RESOURCES

Construction of the onshore storage facility would result in increased storm water runoff at approximately 50 pecent from the storage tank area and 95 percent from the office complex area. The increased runoff would reach Siebert Creek causing a significant increase in sediment concentration and siltation which would degrade water quality, but should not significantly affect fishery resources.

Effluent discharges during operation of the onshore storage facility would enter Siebert Creek increasing stream flow up to 10 percent. These discharges would be subject to NPDES permits and although hydrocarbons in the effluent could degrade water quality, they should have no significant adverse impact on fishery resources.

Abandonment involving removal of the onshore storage facility could result in increased sediment and siltation in Siebert Creek. This could significantly degrade water quality until vegetative cover could be reestablished. Impact on fishery resources would be short term, and would not be significant.

MARINE RESOURCES

Submarine pipeline dredging would suspend sediments and significantly degrade marine water quality for up to 40 days in Port Angeles harbor and adjacent areas. The water quality classification would be changed from excellent to fair. Disturbed sediments and suspended toxic materials (heavy trace metals and hydrocarbons) would destroy some clams and contaminate others. Toxic materials would contaminate clam beds for several months. Contaminated clams could become unfit for human consumption lasting up to a year.

Crude oil spills would significantly degrade marine water quality and lower the water quality classification. The affected area could extend along many miles of the U.S. and Canadian shoreline from the outer coast, through the Strait of Juan de Fuca and into Puget Sound. Possible oil spill trajectories are described in chapter 3 and shown in the Map Addendum. Diving birds, otter, Pacific herring, surf smelt, clams and oysters would probably suffer the highest mortalities, with some species requiring up to 10 years for recovery.

Chronic oil spills could alter the behavior, health, size, and structure of marine organisms, populations, and communities and could concentrate within the food web trace metals found in crude oil. Exposure of phytoplankton and zooplankton to oil, especially eggs and larvae, would cause significant local, unavoidable adverse impacts. Some organisms ingest and pass oil droplets through their digestive system. These organisms and their waste products are consumed by other organisms. Thus, oil and trace metals become concentrated within the food web. Ingestion of oil contaminated organisms and their waste products by filter-feeding shellfish could also contribute to tainting of these organisms.

Certain benthic species in the harbor, such as clams, would suffer slight declines as a result of chronic low level oil pollution. Some fish species, particularly Pacific herring and surf smelt, could also suffer small population declines.

Some birds would be oiled and killed by chronic low level pollution. Others might consume contaminated prey and experience toxic effects such as reduced hatching success. Chronic pollution might displace some otters, seals, and sea lions. No impacts upon whales and porpoises would be expected.

A large spill from a pipeline rupture or tanker accident could have major impacts upon biological resources at all levels. The groups anticipated to suffer the most serious, prolonged impacts would be diving birds, otter, Pacific herring, surf smelt, clams, and oysters. The duration of impacts would exceed 10 years for sensitive species in certain limited areas.

Oil-spill cleanup vehicles or vessels operating near seal rookeries could disturb the animals. Adults disturbed during breeding might abandon their pups, subjecting them to starvation and predation.

TERRESTRIAL VEGETATION

Approximately 159 acres of vegetation would be unavoidably disturbed during installation of the port and onshore storage facilities. The project would also cause the addition of small amounts of air pollutants harmful to sensitive plants into the atmosphere around Port Angeles. Noticeable injury to plants is unlikely.

TERRESTRIAL WILDLIFE

Construction activity and operation of the onshore storage facility would cause bald eagles (an endangered species in Washington) to abandon the Green Point area and adjacent shoreline feeding areas. Loss of this habitat used by 3 to 10 bald eagles and loss of the productive potential of the nest site on Green Point might result in a population decline. Local populations of other non-endangered wildlife species might also experience slight population declines.

CULTURAL RESOURCES

The potential exists that construction of project facilities would destroy unrecorded cultural resources. Excavations at the onshore storage facility and for the submarine pipeline could damage, displace, and bury fossils of Quarternary, Tertiary, and late Pleistocene Age. Cultural resources discovered during construction would still be unavoidably impacted, since not all data could be recovered and the sites or materials would be permanently removed from the data base.

VISUAL RESOURCES

Construction of the port facility and submarine pipelines would dominate panoramic views of Port Angeles harbor from the city, Olympic National Park, and from the Strait of Juan de Fuca during the 18-month construction period. The submarine pipeline ascending to the onshore storage facility would permanently scar the cliff face by changing the color and texture. These areas are all considered moderate to high in visual quality. During operation, the size of berthed and queued tankers would visually dominate the harbor. At Green Point, the large storage tanks and support facilities would contrast sharply with surrounding vegetation, and would be a significant visual intrusion to nearby residents, views from the Strait of Juan de Fuca, and U.S. Highway 101.

Green Point, Washington (looking from the northeast)

LAND USE

The significant unavoidable adverse impacts on land uses from project construction are:

1. Displacement of approximately 110 acres of log storage in Port Angeles Harbor:	Approximately 55 percent of the log storage area along Ediz Hook traditionally leased by ITT Rayonier and Crown Zellerbach would be displaced by dry land storage with a resultant increase in operating costs, truck traffic within the city of Port Angeles, and air quality degradation. Approximately 60 acres of land area would be needed for the displaced log storage. Undeveloped, industrially zoned land is available in the area.
2. Displacement of the pilot station:	Space elsewhere in the harbor would need to be found for the pilot station, which includes two pilot boats and sleeping quarters for 10 to 12 personnel. Any alternate location farther from the end of Ediz Hook would result in increased operating expenses and retard pilot boat service.
3. Displacement of Thunderbird Boat Marina and public boat ramp:	Seasonal small boat moorage and headquarters for annual Salmon Derby. Possible alternative locations have not been identified.
4. Displacement of the Vertical Omni Range station:	A possible alternative location for this air navigation facility has not been established.

Construction activities would conflict with nearby land uses chiefly through nuisance impacts including increased noise, dust, visual disharmony, and street and harbor traffic. Excavation of the sea cliff at Green Point would be inconsistent with Clallam County Shoreline Master Program Regulations and the onshore storage facility would be inconsistent with planned and zoned land use.

Project operations would preclude other possible uses of about 4.3 acres on Ediz Hook, 210 acres of tideland and harbor area, and 242 acres at Green Point.

Oil spill, explosion, or fire might adversely impact land uses adjoining the port and onshore storage facility. The probability of these events and their possible impacts are shown in table 5.1-1.

The process of removing project facilities during abandonment would cause nuisance impacts to adjoining land uses, similar to those incurred during construction.

TABLE 5.1-1 POSSIBLE UNAVOIDABLE ADVERSE OIL SPILL, FIRE, AND EXPLOSION IMPACTS TO LAND USES

Event	Estimated Frequency 1/	Possible Impacts
Large in-transit oil spill in Strait of Juan de Fuca (greater than 10,000 barrels)	88 years	Would impact sparsely developed coastlines. Shoreline of the Pacific Rim, proposed West Coast National Parks on Vancouver Island, and the Makah and Elwha Indian Reservations on the Olympic Peninsula could be impacted.
Large oil spill in Port Angeles harbor (greater than 2,000 barrels)	102 years	Would impact log storage, Coast Guard berth, and intensive industrial, commercial, and recreational land uses bordering the harbor.
Fire at port facility	20 years	Smoke impacts to land uses indicated above, might necessitate temporary interruption of water and road access to Coast Guard station.
Fire at onshore storage facility with damage equal to or greater than $1,000	64 years	Smoke impacts on nearby residential areas.
Tanker explosion in harbor	49 years	Might cause physical damage, loss of life at Coast Guard Station, on nearby vessels in harbor, and to recreationists on Ediz Hook.

Source: OIW 1978

1/ Estimated frequency is expressed as one event every "X" years and does not indicate when the event might occur. Estimates are based on 933,000 barrels per day throughput.

TRANSPORTATION AND UTILITY NETWORKS

During construction the Port Angeles central business district, Marine Drive out to Ediz Hook, and the Old Olympic Highway near the onshore storage facility would experience increased traffic congestion. Travel times would be increased but roadway capacities would not be exceeded. Heavy truck traffic would hasten deterioration of road surfaces.

Local utilities would be required to construct about 3-1/2 miles of 69-kV electrical lines. Construction of the port facility would require relocation of the Vertical Omnirange (VOR) site on Ediz Hook. Relocation of this air navigation aid could probably be accomplished without significant impact to air navigation.

Increased tanker and possibly barge traffic, encroachment of the tanker berths, tanker queueing, and establishment of a nonanchorage area over the submarine pipelines would contribute significantly to vessel traffic congestion at Port Angeles. At ultimate capacity the NTPC proposal would increase large vessel movements in the harbor by about 190 percent over 1977 traffic levels.

An oil spill, fire, or explosion could significantly impact other vessels. Approximately 20 vessels per day arriving or departing Port Angeles harbor would be most exposed to these risks. An oil spill or fire might delay traffic; an explosion could cause injuries to crew members and physical damage to vessels.

Designation of a restricted anchorage area over the submarine pipelines might require that waiting tankers anchor outside the harbor. At times, there might be three or four tankers awaiting berthing at either Port Angeles or Puget Sound facilities. This would cause occasional inconvenience to other commercial vessel traffic.

Electric power requirements for operation of the port and onshore storage facilities (17.5 average and 28.9 peak megawatts for 933,000 barrels per day throughput) might aggravate a potential regional power supply shortage. Port Angeles City Light Department and Clallam County Public Utility District have, to date, refused to commit firm power to NTPC because of possible shortfalls in their firm supply beginning in 1983. If local utilities serve NTPC, they may be required to temporarily discontinue service to NTPC or other customers if critical hydro conditions occur and thermal and nuclear generation is further delayed. In any event, local utilities would be further restricted in their ability to provide additional service.

RECREATION

Construction of the port facility and installation of the submarine pipelines would possibly cause the loss of winter sport fishing in Port Angeles harbor for one season. This would affect about 4,000 anglers. Summer sport fishing would be reduced and suspended sediment in the water would contaminate clam beds for several months, further reducing recreational activity.

Construction and operation of the port facility would detract from and probably cause a decrease in recreational use of Ediz Hook including fishing, scuba diving, beachcombing, bird watching, and sight seeing. Harbor congestion during project operation would detract from pleasure boating and fishing. An oil spill could cause oil fouling of boats, gear, and beaches, and a temporary loss of sport fishing opportunity.

Opportunities for recreational shellfish collecting for an unknown number of recreationists could be reduced for up to 10 years. A tanker explosion at the port facility could cause injury or loss of life to recreationists on Ediz Hook or boating in the harbor. There are more than 400 recreational boats in harbor marinas and unknown numbers of additional boats are regularly launched from ramps.

ECONOMIC CONDITIONS

Construction of the proposed port facility and submarine pipelines would cause a major reduction in shellfish harvests, especially geoducks near Green Point, possibly lasting for up to 10 years. This could result in a loss of about $250,000 per year, which in turn might result in the loss of up to about 17 jobs.

There would be a peak population influx of from 900 to 1,500 persons into the Port Angeles area during the first 4 months of construction. This would represent a population increase of about 2 to 3.4 percent and might result in temporary increases in the prices of some goods and services, particularly rentals. Local school districts would incur increased expenditures of about $300,000. The value of residential property located near the onshore storage facility might be adversely affected.

An oil spill, fire, or explosion would cause unreimbursed damages that might be incurred by individuals, companies, and all levels of government. Chronic oil spillage from the port facility could significantly decrease revenues from shellfish harvests. The local forest product industries would experience increased operating expenses due to the loss of harbor log storage.

SOCIAL CONDITIONS

Project construction would create a demand for 618 housing and lodging units for a 4- to 8-month period decreasing to about 335 units for the remaining construction period. During the peak summer tourist season, June through September, housing and lodging units would be in short supply and rental rates might increase, causing a hardship on retirees and other persons on fixed incomes. Local school enrollments would be increased by about 137 pupils causing an increase of 1.2 percent and 2.8 percent respectively in the Port Angeles and Sequim school districts. Increased enrollments would further aggravate existing overcrowded conditions in the Port Angeles elementary and Sequim junior high school. About three additional law enforcement officers and perhaps one or two additional fire fighters would be needed to maintain current protection levels in the area.

Perceptions of Port Angeles as a small community, attractive to retirees, recreationists, and tourists, might change if the NTPC proposal is approved. Decreased recreational opportunities, the threat of oil spills, fires, and explosions, and the possibility of additional petroleum related or induced industries further reducing the small community atmosphere would be of concern to many Port Angeles and Clallam County residents.

Native American fishing enterprises could be significantly impacted by an oil spill.

5.2 Pipeline System

OIL SPILL, FIRE, AND EXPLOSION RISK

The risk of an oil spill, fire, or explosion would be unavoidable if the project were implemented. The actual events of an oil spill, or explosion may or may not occur according to the statistical analysis presented in chapter 3, but the risk of their occurrence, along with the possible damages incurred, would persist for the life of the project. Potential frequencies and magnitudes of these events are presented in chapter 3.

AIR QUALITY

Fugitive dust emissions in areas where no watering is applied, would range from 3.8 to 5.5 tons per day over a 5-mile line segment. These would cause localized particulate concentrations and result in reduced visibility. Impacts would last for periods of 1 to 2 weeks at any one location. Impacts at main line stations on delivery facilities would be intermittent over a 1-year construction period.

During abandonment, fugitive dust emissions would be similar to those associated with the construction phase.

NOISE

Construction of mainline stations and delivery facilities would result in average noise levels of about 55 dBA at 4,000 feet and about 70 dBA at 1,500 feet from the construction site. Noise might cause intermittent annoyance during the 15-month construction period.

Pipeline construction would cause noticeable increases in noise levels at distances of 2,500 feet or less from the alignment. Average noise levels up to 65 dBA could occur at distances of 500 feet or less. Construction noise might be annoying to nearby residents for periods of 1 to 2 weeks at any one location.

Noise impacts during the abandonment process would be similar to those associated with construction.

TOPOGRAPHY AND GEOLOGY

Construction activities could induce slope failure on unstable and potentially unstable slopes along the pipeline resulting in possible loss of life or limb, and damage to structures, utilities, and construction equipment. Port Williams, Brown Point, the Cascade Range, the Columbia River area, Washington, and Siegel Creek, Montana are known areas of slope instability. Slopes in those areas would also be susceptible to movement during project operation which could cause pipe rupture and an oil spill.

Fault movement along the Prickly Pear fault in Montana and liquefaction of bearing sediments along the pipe route could cause pipe rupture and oil spills.

1,700 to 1,900 cubic yards of fill material per mile would be required to fill in the trench and complete restoration upon project abandonment. Impacts on the numerous borrow areas that would be needed along the route cannot be assessed.

SOILS

Approximately 20,000 acres would be vulnerable to erosion at some point during construction. More than 18,000 acres of soil in the right-of-way would produce nothing during construction. Soil losses of cultivated lands would average approximately 6 tons per acre per year or 50 percent greater than normal. Unprotected surfaces and steeper slopes on forest lands would have annual erosion rates of 0.80 to 3.20 tons per acre compared to a present rate of 0.10 tons per acre.

Unavoidable soil losses on grass and brush land would range from 0.28 to 2.14 tons per acre. Average soil losses from fugitive dust would be 225 pounds per acre of pipeline right-of-way. Wind erosion would occur on approximately 7,600 acres until bare surface areas were protected by mulch or vegetation.

Wind and water erosion during operation would occur at rates equal to or slightly greater than present rates. About 0.34 tons of soil per acre per year would be unavoidably lost in areas with grass cover. This would be equal to approximately .002 inch of topsoil lost annually.

Soil productivity of seasonally wet soils would return to normal in 1 or 2 years.

About 5 percent of productive capacity would be permanently lost on approximately 1,000 acres within the proposed right-of-way. Approximately 1.4 million cubic yards of good quality subsoil would be displaced along 800 miles of the proposed route.

Soil productivity would be unavoidably lost for the 20 year economic life of the pipeline on areas occupied by pump stations, pressure reducing stations, block valve locations, access roads, and other facilities.

Oil spills would cause unavoidable losses in soil productivity for several years. The potential area of contamination would vary from tens of square feet to hundreds of acres depending upon the size of the spill, topography, and soil characteristics.

Project abandonment would again subject soil to wind and water erosion. Soil productivity would be further reduced by another 5 percent.

AQUATIC RESOURCES

Surface water quality would be significantly degraded for several days by increased turbidity and siltation during clearing, trenching, pipe installation, and backfilling operations.

Stream baseflow would be decreased for the 1- to 2-day hydrostatic test water withdrawal period. A 5 percent or less reduction of stream discharge would occur if streams had average or greater flow during withdrawal periods.

Construction through seasonally shallow and perched aquifers could modify ground water movement and cause sediment-laden waters to reach shallow aquifer zones reducing water quality for several months.

For 1 or 2 years until revegetation occurs, erosion at streambanks would increase turbidity and siltation downstream from the crossing for several days during spring runoff.

An oil spill would significantly but temporarily degrade water quality for many miles downstream from the spill site. Oil spills could also contaminate ground water supplies up to 20 years. Municipal and domestic supplies could become contaminated. The spill risk for spills equal to or greater than 2.4 barrels occurring at stream crossings is estimated to be one spill every 91 years, the comparable frequency of risk for potable water.

Sedimentation of spawning areas would reduce salmon and trout populations. These areas are described in chapter 3. Several spawning cycles would be required for reduced populations to recover to preproject levels. The initial population reductions would probably not be noticed in ocean fisheries; however, reductions might be noticed in river fisheries in severe cases. In subsequent years during project operation, populations would probably recover to within the normal range of population fluctuations.

Oil spills could significantly reduce fish populations for several miles downstream from the spill site. Several years could be required for the reduced populations to fully recover to prespill levels. The reduction of resident trout and warm water fish populations would probably be noticed only after a large spill. The reduction of salmon and searun trout populations would probably not be noticed in ocean fisheries, but might be noticed in river fisheries, particularly following a large spill if large numbers of one or more year-classes of fish were eliminated.

MARINE RESOURCES

Trenching activities for the submarine pipeline between Port Williams and Point Partridge would displace 488,000 to 553,000 cubic yards of sediment and degrade marine water quality for 45 to 61 days. Trenching between Polnell Point and Brown Point would displace 146,000 to 166,000 cubic yards of sediments and degrade marine water quality for about 40 days. Population reductions of up to 40 percent clams and oysters, and possibly Pacific herring and surf smelt would occur in Sequim, Discovery, and Skagit Bays and in Saratoga Passage, lasting possibly for several years. Some clams could become unfit for human consumption for several months following construction.

An oil spill would degrade marine water quality in the Strait of Juan de Fuca and Puget Sound. Salt marshes and eelgrass beds in these areas could become oiled and eelgrass could be reduced. Local populations of clams, oysters, Pacific herring, surf smelt, salmon, crabs, shorebirds, and waterfowl could be reduced, with mortalities approaching 100 percent within the affected area. Population recoveries would require 10 or more years for some species. The areas susceptible to these impacts are described in chapter 3 and shown in the Map Addendum.

TERRESTRIAL VEGETATION

Construction would unavoidably disturb about 3,900 acres of forest, 6,600 acres of rangelands, 400 acres of wetlands, and 300 acres of riparian woodland. Timber production would be lost for the life of the project on about 2,900 acres. The quality of disturbed sites as plant habitat would be unavoidably reduced. Construction through wetlands could cause surface and subsurface drainage and the loss of quantified wetland vegetation. Some vegetation adjacent to the cleared right-of-way would be injured or weakened during construction. Some endangered plant species might be unavoidably destroyed.

An oil spill could cause damage and destruction of vegetation within and beyond the right-of-way, leaving the area void of vegetation for several years. The most extensive and long-lasting damage from oil spills would occur in wetlands. Abandonment activities would again disturb vegetation within the right-of-way.

TERRESTRIAL WILDLIFE

Disturbances during construction could cause bald eagles and peregrine falcons to temporarily abandon wintering areas, roosting and feed areas, and nest sites. Abandoning nest sites during the nesting season would prevent successful reproduction and reduce their local populations. Loss of habitat and disturbance could reduce local populations of osprey, deer, bighorn sheep, sage grouse, and sharptail grouse. Loss of habitat would reduce local pheasant and waterfowl populations. Actual amounts of critical habitat losses for the above species have not been qualified. Losses to local populations could be significant, but it is not expected that cumulative losses to any species would be regionally significant. Population recovery would require several years for most species which might incur small but permanent reduction. Impact locations are shown in the Map Addendum.

Lost waterfowl habitat in the prairie pothole region could reduce waterfowl population by 32,000 birds per year. Wildlife production could be reduced for 1 year if maintenance activities occur during the breeding season.

Oil spills could reduce waterfowl populations, particularily in the prairie pothole region.

CULTURAL RESOURCES

Some presently unknown cultural and paleontological resource sites along the pipeline right-of-way might not be identified during preconstruction surveys. Some damage would be unavoidable before construction could be halted.

Sites which could not be avoided and thereby preserved in place would, after data recovery, be destroyed. Any potential for future study and/or interpretive development would be lost.

Pipeline construction would give access to areas which were previously little traveled. Inadvertant damage to sites from use of the land, and intentional damage by collectors would subsequently occur.

VISUAL RESOURCES

Installation of the pipeline in sea cliffs near Port Williams, Point Partridge and Brown Point, Washington, would introduce a permanent, high visual contrast in the color and texture of the cliff faces. Similar impacts would also occur at many river crossings along the proposed pipeline route. The cleared right-of-way and main line stations in the Snoqualamie Pass area of Washington and in mountainous areas of Idaho and western Montana would contrast sharply with their surroundings causing significant adverse visual impacts, in these areas of moderate to high visual quality.

LAND USE

Significant unavoidable impacts include temporary disruption, and nuisance impacts of dust, noise, visual disharmony, and traffic delays to adjoining land uses. Nuisance impacts would be most severe near the 100 acres of construction in urban fringe areas and in confined areas such as Snoqualmie Pass, Washington; Prichard

Creek Valley, Idaho; and Prospect Creek and Clark Fork River valleys, Montana. Construction activities would require the use of approximately 20,000 acres.

Construction activity would preclude production for one season on approximately 6,400 acres of cropland and improved pasturelands. Subsequent years productivity might be reduced by 5 to 10 percent. These impacts would occur on 3,900 acres or less of land having soils qualifying for prime farmland designation. About 80 acres of agricultural land would unavoidably be removed from production for the duration of the project.

Approximately 6,600 acres of rangelands would be disturbed during construction with the loss of at least 1-year's forage production. Subsequent years productivity might be lessened by 5 to 10 percent. About 155 acres of rangeland would be removed from forage production for the duration of the project. About 3,900 acres of forest and woodland would be cleared during construction, with most of this acreage removed from production for the life of the project.

Significant impacts to land use might occur as a result of an oil spill and subsequent reclamation activity. The amounts and types of land uses at risk from an oil spill would be roughly proportional to the percentage of their occurrence within the right-of-way (urban less than 1 percent, forestland about 22 percent, agricultural lands 35 percent, and rangelands 37 percent, risk to other unidentified lands make up the remainder).

About 100 acres of urban area would be exposed to the risk of oil spill, fire and explosion damage. Major pipeline repair would result in nuisance impacts similar to those incurred during construction.

An oil spill could damage agricultural crops, decreasing production for 1 to 5 years, depending on the size of the oil spill, effectiveness of reclamation efforts, time of year, soils, climate, and type of crop grown. Alfalfa, wheat, oats, and barley would be the crops most likely impacted.

Removal of the pipeline system would cause nuisance impacts to adjoining land uses, particularly urban land uses, similar to those incurred during construction.

TRANSPORTATION AND UTILITY NETWORKS

Project-related vehicles and construction activity would cause traffic congestion on some roads and highways near the pipeline for periods up to 1 month.

In many areas, particularly urban fringes, and in areas where alternative travel routes are limited or not available, project-related traffic and construction activity would cause longer travel times on local roads and highways. Heavy truck traffic would likely cause significant amounts of road damage.

Construction activity might damage nearby transportation and utility systems. About 330 crossings of other major systems and 504 miles of adjacent construction would take place. The probability of damage occurring is significantly reduced by the various crossing and joint use permits required, however the safety of other nearby systems would still be subject to damage by human error.

Project operation (requiring up to about 106 average megawatts in Washington and Idaho) would further aggravate possible Pacific Northwest regional power supply shortages (forecasted to be in excess of 2,000 megawatts in the mid 1980s), which would increase the likelihood of power curtailments and limit the local utilities' ability to enter into new service contracts. Under Washington State law, energy supply facilities might be exempt from power curtailments in times of an energy shortage, thus curtailments, if they occur, might have to be absorbed by other customers.

An oil spill and resulting clean up activity might cause damage to nearby transportation and utility systems and would likely cause traffic congestion on roads accessing the spill site for up to several weeks depending on the size and location of the spill.

Transportation and utility facilities near the pipeline might be physically damaged during pipeline removal, which might take them out of service for up to several hours or days.

RECREATION

Contamination and perhaps loss of some shellfish beds caused by submarine pipeline trenching could significantly reduce recreational collection for several years potentially affecting 216,000 user trips per year.

Pipeline construction activities through such high recreational use areas as Snoqualamie Pass, Washington; Heyburn State Park and Cataldo areas in Idaho; and along Prospect Creek, and Clark Fork River in Montana; would inconvenience recreationists in these areas for one winter or summer season depending on construction timing. Traffic congestion, noise, dust, and the scarcity of accommodation would discourage recreational use.

The linear right-of-way corridor would visually detract from enjoyment of the Ashael Curtis Recreation Area, Pacific Crest Trail, Continental Divide National Scenic Trail, and the Lewis and Clark National Historic Trail. The presence of the right-of-way would encourage off-road vehicle use which could be disruptive to other recreational activities such as wildlife viewing, hunting, hiking, and cross-country skiing.

An oil spill from the submarine pipelines would cause significant losses to shoreline and marine recreation in Puget Sound. If a spill occurred during the summer season more than 1.4 million recreation visits to shoreline parks could be curtailed. A decrease of 384,000 or more shellfish collecting visits could also occur. Elsewhere along the pipeline an oil spill, and the resulting clean up activity could cause significant losses to primarily water-related recreation including angling, floatboating and waterfowl hunting.

ECONOMIC CONDITIONS

Shellfish and bottomfish harvest in the vicinity of the submarine pipelines would be reduced and possibly eliminated for several years. The economic losses involved might be significant. Pipeline construction would cause temporary population increases ranging from 120 to 220 persons which might be significant in some eastern Montana Counties. Broadwater, Wheatland, Garfield, and McCone Counties might experience crowded conditions in service establishments and temporary increases in the prices of goods and services, particularly rentals.

A submarine pipeline rupture would result in an oil spill which would seriously reduce and possibly eliminate shellfish and bottomfish harvests within the affected area for several years. Individuals, companies, and all levels of government would incur damages and expenses which would probably not be fully reimbursed. The potential frequency for a submarine pipeline spill equal to or greater than 2.4 barrels is estimated to be one spill every 54 years.

SOCIAL CONDITIONS

Construction activity would cause a temporary 2- or 3-month strain on housing in some rural areas particularly during summer months. The increased transient population would cause crowded conditions in service establishments, and increase demands on police and fire protection services.

An oil spill could result in significant loss to Native American tribal fish enterprises in western Washington. Oil spill clean up could impose significant burdens on local governments. Disposal of large quantities of oily waste materials would require special handling and perhaps require that additional disposal sites be located and approved.

6

SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

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THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

(Proposal of the Northern Tier Pipeline Company)

This chapter is a summary discussion of issues and an evaluation of the anticipated short-term and long-term effects of NTPC's proposal. Short-term is defined as the duration of project life, which is likely to last at least 20 years. Long-term is the period extending beyond project abandonment.

The major purpose of the proposed project is to provide a common-carrier crude oil transportation system capable of supplying crude oil to northern tier and inland states. Design provisions would enable the system to be readily modified to supply east Puget Sound refineries, if required. The benefits from accomplishing these objectives would accrue to crude oil producers, refiners, NTPC, local taxing bodies, and to consumers of refined products in northern tier and inland states. The major short-term trade-offs resulting from the proposal would be the loss of existing environmental values in Port Angeles caused by the expansion and use of harbor facilities for very large crude carriers (VLCC). There would be a short-term commitment of land for the onshore storage facility and pipeline system corridor with the likelihood that similar uses would continue in the long-term. There would be a short-term risk of environmental damage from oil spills, fire, and explosion. There would be a short-term risk to human health and safety. Intermittent periods of air quality degradation also would be experienced in the Port Angeles area and, possibly, in Olympic National Park.

6.1 Port and Onshore Storage Facilities

The two proposed tanker unloading berths would require about 4.3 acres of land on Ediz Hook. Approximately 45 surface acres of Port Angeles Harbor and tidelands would be occupied or enclosed and about 210 acres of the harbor would be used intermittently during project operations. The onshore storage facility at Green Point would occupy 242 acres of land.

Port Facility

The short-term use of Port Angeles harbor would cause several major changes. The Federal Aviation Administration's Vertical Omni Range (VOR) installation on Ediz Hook, more than 100 acres of log storage area, a pilot station, a marina, and a boat launch would require relocation. These changes would remain during the long-term.

The long-term productivity of marine resources in Port Angeles harbor and adjacent areas should not be affected by short-term losses incurred during project construction and operation. Long-term productivity would be affected if a major oil spill occurred.

The commitment of present harbor uses to project uses could preclude the development of additional deep draft piers to handle commodities other than crude oil during the short term. This could result in long-term changes as well. The tanker unloading facility might continue to operate beyond the short term, thus precluding other deep water uses of the harbor. Conditions in the Port Angeles area are not favorable for the development of refineries or petrochemical plants. Therefore, short and long-term attraction of petroleum-related industries in the port area are not likely to occur. In order not to exceed the Prevention of Significant Deterioration incremental air quality standards, other industries could be precluded from expanding or locating in the area.

The proposal is perceived by many in Port Angeles and Clallam County as a trade-off of highly valued existing quality of life features for an incompatible industrial installation with limited benefits for the local area. The short-term commitment of the area's resources to project purposes could make it difficult to maintain and enhance, for the short and long-term, the amenities and resources which support the local population. The project is also perceived as having short-term and potential long-term risks to health, safety, and the general quality of life which would not be off-set by short-term economic benefits. The trade-off can be seen as a short-term commitment to an industrial installation with a sacrifice of a way of life based on local natural resources.

There would be local degradation of air quality and increased noise during construction. During operation at a 933,000 barrels per day throughput, the Class I Prevention of Significant Deterioration standards for sulfur dioxide at Olympic National Park Visitor's Center would be exceeded about 10 days each year. Class II incremental standards for sulfur dioxide would be exceeded once or twice a year in Port Angeles. These short-term uses of the airshed would not continue during the long-term.

Large oil spills from tankers, submarine pipelines, or the unloading facility would result in short-term environmental damage beyond that related to normal project operation. Reduced productivity of marine resources during the short-term would continue during the long term. Minor operational spills would be relatively frequent resulting in localized reduction of marine water quality for short periods. The cumulative effect of such spills would likely result in some displacement of marine plants and animals and in long-term reduction of productivity in local areas.

A major spill is not likely to occur during the life of the project. However, should one occur, it would affect marine resources, water quality, shorelines, shoreline structures, boats, waterfowl, visual resources, and air quality over a wide area, and could reach both American and Canadian shorelines. A major spill could kill several thousand waterfowl, disrupt salmon migration, damage clam and crab habitat for several years and destroy spawned herring eggs. The short-term loss in productivity would be significant. Some loss of marine resource productivity could continue during the long-term.

Onshore Storage Facility

The short-term use of 242 acres at Green Point would entail some long-term commitments of environmental resources. The land, which is mainly forested and currently zoned for residential use, could conceivably be used for other commercial or industrial use should the project be abandoned. The topography and soils of the site would be permanently altered which would limit future use. About 140 acres of existing forest vegetation would be lost for the long-term. Ground water quality could be degraded into the long-term should a major oil spill occur at the storage facility.

Bald eagles use Green Point as winter habitat. Use of the area for the project would probably destroy eagle habitat and eliminate short- and long-term use of the area as a roosting or nesting site.

During the estimated 18-month-long construction period of the onshore storage facility air quality would be reduced locally and noise could be an annoyance to some residents. However, it is not expected that federal or state air quality standards would be exceeded. During the short-term operation phase there would be continous hydrocarbon emissions from the storage tanks. These should not exceed standards for hydrocarbon or ozone. Emissions would not occur following abandonment.

The presence of the onshore storage facilityes would cause a deterioration of visual quality at Green Point for the life of the project. The initial proposed throughput of 709,000 barrels per day would require 11 storage tanks. Seven additional tanks would be needed for the ultimate design capacity of 933,000 barrels per day. Each tank would be 56 feet high, with a diameter of 285 feet. The pipeline notch up the face of the bluff at Green Point would permanently degrade the shoreline's visual quality.

6.2 Pipeline System

Approximately 20,000 acres of land would be disturbed by construction of the pipeline system and related facilities. About 15,000 of those acres would be required during the short-term for operation and maintenance of the pipeline, pump stations, and delivery facilities. Most agricultural and grassland areas within the pipeline corridor would be returned to pre-construction uses within several years, however, buildings and trees would be prohibited during the short-term. Approximately 80 acres of agricultural land, 155 acres of rangeland/shrubland and 2,950 acres of forest/woodland would be converted to exclusive project use for the short-term.

The use of land resources for the pipeline right-of-way would not significantly affect either short or long-term productivity. In mountainous, forested areas the opening of a corridor could significantly alter land use and preclude maintenance of undeveloped areas. However, the proposed pipeline route would usually follow existing cleared transportation and utility corridors in these areas. The proposed pipeline would require additional clearing along existing corridors and new clearing in several short segments, however, there are no cases where such clearing would provide new access to extensive undeveloped areas. Once established, a utility corridor tends to attract additional new utilities, especially in congested areas. Therefore an initial commitment is likely to result in long-term utility corridor use.

In some areas of Washington, NTPC's planned use of existing BPA power line corridors could restrict that agency's plans for future expansion. Establishing a crude oil transportation system would provide the opportunity for refineries and petro-chemical industries to locate and expand along the route.

Along most of the proposed pipeline route there would be negligible effects on topography. However, in steep terrain the excavation of a right-of-way of workable width would constitute a long-term alteration of the topography causing a long-term reduction of visual quality.

Construction of the pipeline system would adversely affect air quality, noise levels, soil productivity, vegetation, wildlife, water quality, fish in freshwater streams, and recreational activities during the short-term. None of these short-term uses are likely to significantly reduce long-term maintenance or productivity of these resources.

In most cases, cultural resources along the pipeline corridor would be excavated by professional archaeologists prior to construction. This use of cultural resources would be a trade-off in which some short-term value would be obtained in exchange for the loss of potentially greater long-term value. In some cases, cultural resources would probably be destroyed by construction equipment resulting in long-term loss of value.

Electric power required by NTPC pump stations may exceed firm power supplies available to local utility companies. This regional power supply problem is expected to persist through the mid-1980's. East of the Rocky Mountains no power supply problems would be anticipated. In potential problem areas, short-term requirements for power could affect the ability of local utilities to provide firm power. It increases the possibility that utilities might curtail power to other customers. Following project abandonment, there would be additional power available for other customers.

Construction of the pipeline would require a variety of social and community services in towns along the route during the construction period. None of these human resource uses during the short-term would require significant trade-offs or constrain long-term opportunities.

Wages and property taxes derived from pipeline construction and operation would provide economic benefits to communities and to counties crossed by the pipeline. This could result in significant short-term beneficial impacts. Abandonment of the project would eliminate these benefits for the long-term.

Minor pipeline leaks are expected to occur frequently throughout the short-term. Such spills would require the use of some resources in the local area for a short time. Spills could have long-term adverse effects. There could be unknown long-term effects of oil spills on soil productivity, but recent experience and research suggests that prespill conditions can be reestablished within 5 to 10 years depending upon soil type, climate, and reclamation effort. Oil spills on land surfaces could result in degradation of ground water quality into the long-term.

Oil entering streams would result in temporary degradation of water quality and destruction of some fish and other freshwater organisms and their habitats. Effects would be carried downstream for some distance depending on spill size and stream characteristics. In some areas, a spill could damage marine resources or freshwater lake resources, however, the damage from minor spills would probably be ameliorated within a few years. Short-term reduction in fish productivity could result from oil entering downstream fish hatcheries or contaminating significant spawning areas. Oil spills would not likely alter the long-term productivity of fishery resources.

Oil spills in waterfowl nesting or concentration areas could cause short-term and possibly long-term loss of water fowl productivity. The seriousness would depend upon season of occurrence and success of habitat reclamation. Construction and operation of a pipeline across wetlands used by waterfowl involves a possible long-term loss of waterfowl productivity caused by habitat destruction.

A major pipeline oil spill is unlikely to occur during the short-term. Should one occur the significance of environmental damage would depend on the time, location, size of spill, success of cleanup efforts, and speed of reclamation. The potential for long-term reduction of resource productivity would be greater for major spills than minor leaks.

In summary, the proposed project would cause both short-term and long-term adverse and beneficial changes to various components of the environment. The project would have significant effects on the preservation, maintenance, and enhancement of existing environmental values in the Port Angeles area. The trade-off would provide short-term economic benefits in exchange for a change of life style with some risks to present and future recreation, commerce, health, and safety. Along the pipeline system some resources would be used during construction. These resources, plus those committed for the short-term, would not involve any significant alterations in long-term productivity. The major trade-off involves the risk of oil spills, fires, and explosions, with possible resultant damage to man and his environment, in exchange for short-term economic benefits of supplying oil to refineries in northern tier and other inland states.

Aerial view of Ediz Hook — Port Angeles, Washington

Northwest Air Photos, Port Orchard, Washington 1974

6.3 Cumulative Impacts: Potential To Supply Puget Sound Refineries

Construction of the proposed crude oil transportation system would make possible an alternate method of supplying 350,000 barrels per day of crude oil to four refineries on the east side of Puget Sound. Currently these refineries are supplied by tankers. Development of this method would require action by NTPC as well as others. It is likely a separate environmental statement would be required for these actions.

Background

The issues of existing tanker traffic in Puget Sound and the possibility of development of a crude oil transshipment facility in Washington state waters have generated widespread interest and controversy in both legislative and public forums. As a result of these concerns former Washington Governor Daniel J. Evans added a policy statement to the Washington Coastal Zone Management Program. The statement indicates that the state "positively supports the concept of a single, major crude petroleum receiving and transfer facility at or west of Port Angeles" and that the facility "shall be designed to include provisions to supply existing refineries in Whatcom and Skagit Counties."

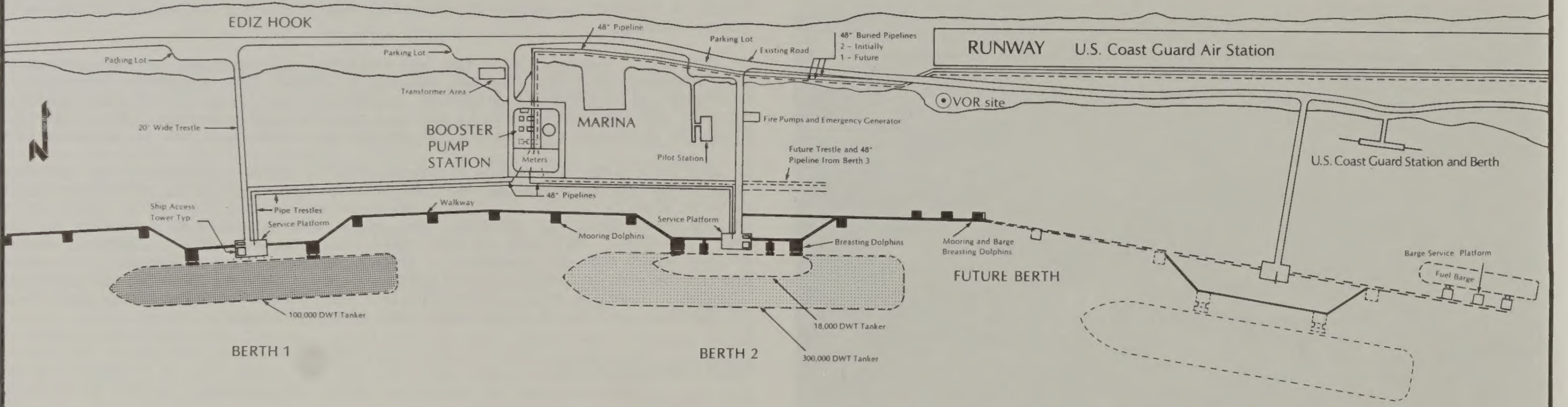
In July 1977, Governor Dixie Lee Ray requested the Secretary of Commerce delete that statement from the approved Washington Coastal Zone Management Program. The Department of Commerce is preparing an environmental statement on the impacts of deleting that statement prior to making a decision on the request. The Draft Environmental Statement considering the action was filed with EPA in November 1978.

In accordance with that policy statement, NTPC's proposal includes design modifications to the tanker unloading facility, onshore storage facility, and the initial 66 miles of pipeline which, if constructed, would enable east Puget Sound refineries to utilize the system. In addition, NTPC would need to construct a storage facility near Arlington. No other actions would be required by NTPC. However, another company would need to construct a storage facility near Arlington, 21 miles of pipeline between Arlington and Burlington to connect with the existing Trans Mountain Corporation pipeline and a storage facility near Burlington. The cumulative effects and potential impacts of these changes are discussed below.

Action Required by NTPC

Port Facility

The expansion of the project to transport up to 1.283 million barrels per day would require a third tanker unloading berth on Ediz Hook, a third pump unit on the booster pump platform, and a third submarine pipeline across the harbor to Green Point (see figure 6.3-1). The third berth would require about 2 additional acres on Ediz Hook. The boat dock at the Coast Guard Station would need to be relocated and additional modifications might need to be made at the air station. It is possible the air station would become inoperative because of these changes. Additional energy requirements for the third pump unit have not been estimated. The installation of the third submarine pipeline, which would be parallel and adjacent to the two proposed submarine pipelines would disturb approximately 40 additional acres of harbor bottom.



Proposed Port Facility Modified to Serve Puget Sound Refineries

Not Drawn To Scale

Figure 6.3-1

Source: Northern Tier Pipeline Company

The increase in throughput would increase the adverse impacts on air quality in the Port Angeles harbor area. The Class II PSD increments for sulfur dioxide emissions would likely be exceeded four days per year with a throughput of 1.283 million barrels per day. The Class I standards for sulfur dioxide in Olympic National Park probably would be exceeded about 12 days each year. Other air quality standards would not be exceeded in the Port Angeles area.

If the pipeline throughput is increased to 1.283 million barrels per day and the four Puget Sound refineries were supplied by pipeline, there would be substantial changes in tanker and support vessel traffic in the Strait of Juan de Fuca and Port Angeles harbor. The additional throughput would generate approximately 116 additional tanker calls per year in Port Angeles harbor, for a total of 511 tanker calls per year with an ultimate throughput of 1.283 million barrels per day. There would be corresponding increases in the frequency of support vessel movement.

This change would cause crude oil tanker traffic in Puget Sound to be reduced or eliminated. The traffic of refined product tankers traveling within Puget Sound would probably not be affected. NTPC has proposed to utilize barges and ships from other west coast ports for supplying low sulfur bunker fuel to tankers utilizing its port facility. Therefore, no incremental risk of oil spills from the fuel barge traffic in Puget Sound would be anticipated.

A comparison of the cumulative risks of marine oil spills from tankers with increased throughput has been evaluated for in-transit and at-berth conditions. Table 6.3-1 shows the estimated frequency of in-transit spills and table 6.3-2 shows the estimated frequency of at-berth oil spills.

TABLE 6.3-1 ESTIMATED FREQUENCY OF IN-TRANSIT TANKER SPILLS

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty 1/ 933,000 bpd 395 Port Calls/Yr One Spill Every:	1,283,000 bpd 511 Port Calls/Yr One Spill Every:
2.4 - 10	6.1 years (4- 21)	4.7 years (3- 16)
10.1 - 50	13.6 years (8- 47)	10.5 years (6- 36)
50.1 - 100	59.4 years (35-204)	45.9 years (27-158)
101.0 - 200	35.5 years (21-122)	27.4 years (16- 94)
201.0 - 2,000	44.8 years (26-154)	34.6 years (20-119)
2,001.0 - 10,000	35.5 years (21-122)	27.4 years (16- 94)
over 10,000	88.2 years (53-302)	68.2 years (40-234)
Any spill ≥ 2.4	2.9 years (1.7-10)	2.3 years (1.3-7.7)

Source: OIW 1978

1/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limit based on a derived historical in-transit spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills in transit.

TABLE 6.3-2 ESTIMATED FREQUENCY OF AT-BERTH TANKER SPILLS

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty1/ 933,000 bpd 395 Port Calls/Yr One Spill Every:	1,283,000 bpd 511 Port Calls/Yr One Spill Every:
2.4 - 10	0.8 years (0.5- 1.3)	0.6 years (0.4- 1.0)
10.1 - 50	2.1 years (1.5- 3.6)	1.6 years (1.2- 2.8)
50.1 - 100	15.9 years (11 - 27)	12.2 years (8.8- 21.0)
101.0 - 200	23.2 years (16 - 39)	17.7 years (13.0- 30.0)
201.0 - 2,000	21.3 years (15 - 35)	16.3 years (12.0- 28.0)
2,001.0 - 10,000	102.0 years (72 -170)	78.0 years (56.0-132.0)
over 10,000	255.0 years (180 -425)	195.0 years (140.0-330.0)
Any spill ≥ 2.4	0.51 years (0.36 - 0.85)	0.39 years (0.28 - 0.66)

Source: OIW 1978

1/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on a derived historical at fixed-berth tanker spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills at berth.

Table 6.3-3 shows the comparison of the estimated frequency of in-transit tanker fire and explosion incidents under increased throughput conditions.

TABLE 6.3-3 ESTIMATED FREQUENCY OF TANKER FIRE AND EXPLOSION INCIDENTS IN GREATER PUGET SOUND

	Fires		Explosions	
	395 Port Calls/Yr. 933,000 bpd One Incident Every:	511 Port Calls/Yr.1/ 1,283,000 bpd One Incident Every:	395 Port Calls/Yr. 933,000 bpd One Incident Every:	511 Port Calls/Yr.1/ 1,283,000 bpd One Incident Every:
Coastal areas 2/	25 years	28 years	22 years	25 years
Harbor areas 3/	8.7 years	8.9 years	21 years	22 years

Source: OIW 1978

1/ Fire and explosion risks decrease because existing crude oil tanker traffic to Puget Sound refineries would be reduced or eliminated if the refineries are served by the NTPC system.

2/ Coastal areas extend from the harbor entrance to 50 miles offshore. Figures apply to tankers in transit to Port Angeles.

3/ Harbor areas include harbor entrance, harbor, and berth. Figures apply to the five tanker ports in Greater Puget Sound.

Onshore Storage Facilities

Seven additional storage tanks would need to be constructed at the Green Point site to accommodate the additional 350,000 barrel per day throughput (see figure 6.3-2). Additional holding basins and oil-water separators would be constructed with the added storage tanks. Most of the 242-acre site would be developed to accommodate the cumulative total storage capacity of 13.6 million barrels. With this larger volume there might be a slight increase in ozone production in the vicinity of the onshore storage site, however, the impact caused by ozone would be negligible.

Approximately 27,331 horsepower would be required at the initial pump station on Green Point to accommodate the cumulative total of 1.283 million barrels per day. This is an increase of 10,268 horsepower, or 60 percent over that required for a throughput of 933,000 barrels per day. The additional horsepower would increase annual electrical energy consumption of the pump station by approximately 61 million kilowatt hours, or 55 percent over that required for a throughput of 933,000 barrels per day. The cumulative total energy requirement for the initial pump station would be approximately 171.4 million kilowatt hours annually.

Storage facilities would be required for 2.1 million barrels at Arlington. Since design details are not available, it is not known what the impacts associated with this storage facility would be.

A comparison of the oil spill risks associated with the increased volume of storage is shown in table 6.3-4.

TABLE 6.3-4 ESTIMATED FREQUENCY OF OIL SPILLS
AT ONSHORE STORAGE FACILITIES 1/

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty2/	
	9,810,000 barrels Stored 3/ One Spill Every:	17,225,000 barrels Stored 4/ One Spill Every:
2.4 - 10	1.6 years (1.4-2.1)	0.9 years (0.8-1.2)
10.1 - 100	1.2 years (1.0-1.5)	0.7 years (0.6-0.9)
101.0 - 1,000	4.4 years (3.6-5.6)	2.4 years (2.0-3.2)
1,001.0 -10,000	53.0 years (44-67)	30.0 years (25-40)
Any spill ≥ 2.4	0.59 years (0.48-0.76)	0.34 years (0.27-0.43)

Source: OIW 1978

1/ Oil spill risks for the expanded throughput conditions are based on the combined storage capacities of all facilities, as follows: Green Point - 13.625 million barrels; Arlington - 2.1 million and 1.0 million barrels; Burlington - 500,000 barrels.

2/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on a derived historical tank farm spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all spills from tank farms.

3/ 933,000 bpd throughput.

4/ 1.283 million bpd throughput.

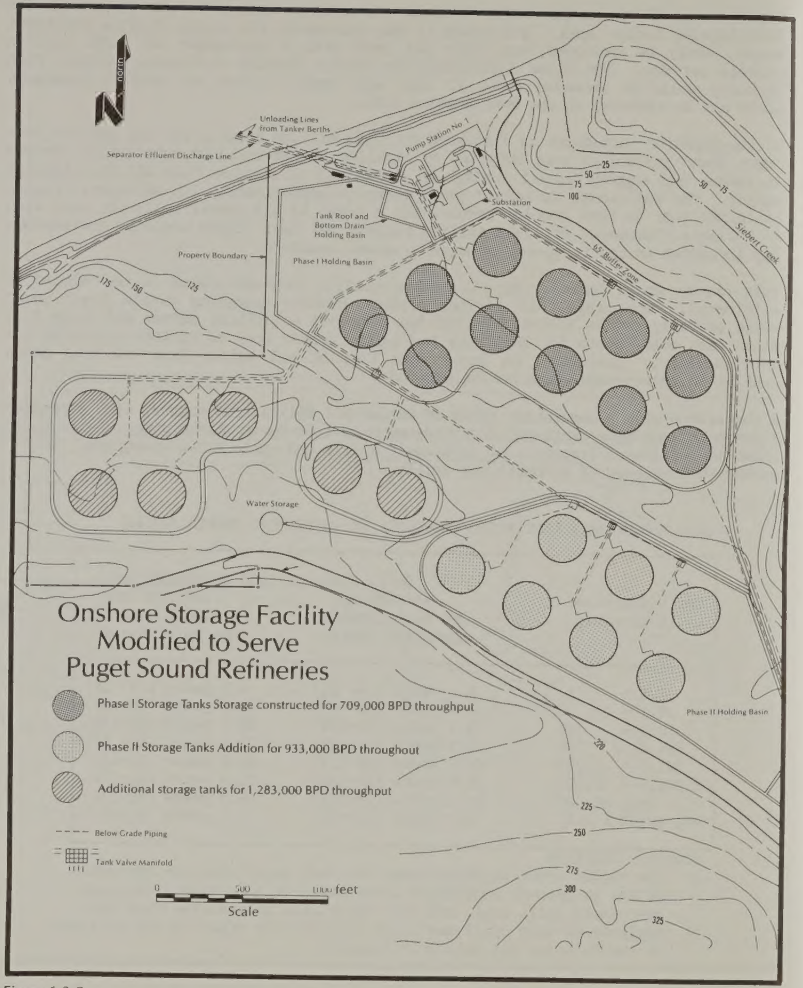

north
N
Unloading Lines from Tanker Berths
Separator Effluent Discharge Line
Pump Station No. 1
Substation
Tank Roof and Bottom Drain Holding Basin
Property Boundary
Phase I Holding Basin
65' Buffer Zone
Siebert Creek
25
50
75
100
50
75
175
150
125
Water Storage
Phase II Holding Basin
220
225
250
275
300
325
Onshore Storage Facility Modified to Serve Puget Sound Refineries
Phase I Storage Tanks Storage constructed for 709,000 BPD throughput
Phase II Storage Tanks Addition for 933,000 BPD throughout
Additional storage tanks for 1,283,000 BPD throughput
Below Grade Piping
Tank Valve Manifold
0
500
1000 feet
Scale

Figure 6.3-2

Source: Northern Tier Pipeline Company

Table 6.3-5 shows the estimated frequency of fire damage at onshore storage facilities which NTPC would provide. It is not known what the estimated frequency of fire damage would be for the two additional storage facilities.

TABLE 6.3-5 ESTIMATED FREQUENCY OF FIRE DAMAGE AT ONSHORE STORAGE FACILITIES 1/

Fire Damage Magnitude	Fire Frequency and Uncertainty 2/ One Fire Every:
$ 1,000 - $ 10,000	36 years (24-76)
$ 10,000 - $100,000	72 years (47-150)
$100,000 - $500,000	57 years (37-120)
over $500,000	265 years (175-555)
Any fire ≥ $1,000	16 years (10-33)

Source: OIW 1978

1/ Includes combined storage of 13.625 million barrels at Green Point and 2.100 million barrels at Arlington.

2/ The ranges shown in parentheses for each fire damage magnitude category are estimates of the 95 percent confidence limits, and were calculated by assuming that the variance of each fire magnitude category was equal to the variance of the data for all fires.

Pipeline System

Modifications would not be required for the initial 66 miles of pipeline from Green Point to Arlington since design specifications would be adequate for the additional throughput capacity. Frequency of pipeline spills per mile for the cumulative total throughput of 1.283 million barrels per day would be the same as for other throughputs. Therefore, between Green Point and Arlington, the risk of pipeline spills would be the same. For the 21 miles of pipeline between Arlington and Burlington, the estimated risk of pipeline spills equal to or greater than 2.4 barrels (100 gallons) would be one spill every 22 years.

Action by others

In addition to actions required by NTPC, another company would need to construct a 1 million barrel storage facility near Arlington, 21 miles of pipeline between Arlington and Burlington, and a 500,000-barrel storage facility near Burlington. It is not known what the impacts associated with these actions would be. However, it is likely that the 21 miles of pipeline would be constructed along an existing right-of-way. (See figure 6.3-3.)

Cumulative Cost Estimates

Based on May 1978 costs, the additional investment required to increase the throughput capacity from 933,000 barrels per day to 1.283 million barrels per day has been estimated in table 6.3-6.

TABLE 6.3-6 ESTIMATED ADDITIONAL INVESTMENT TO INCREASE THROUGHPUT TO 1.283 MILLION BARRELS PER DAY

Tanker unloading facility	$37,226,000
Onshore storage facility	31,477,000
Delivery facility	17,436,000
Total 1/	$86,139,000

Source: NTPC 1978

1/ Costs for modification of the initial pump station have not been included.

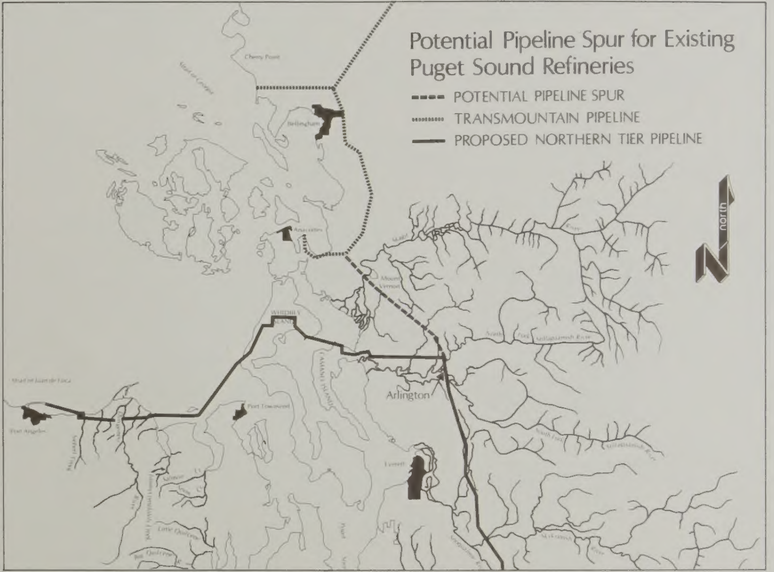
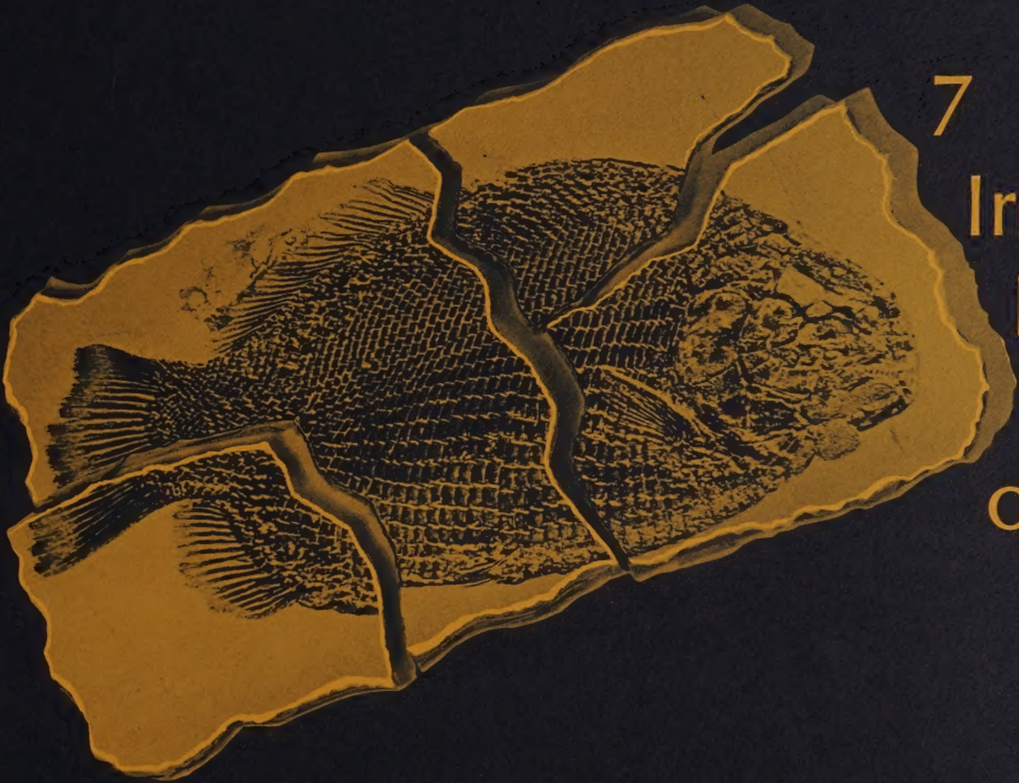


Figure 6.3-3



7

Irreversible and Irretrievable Commitment of Resources

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IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES
(Proposal of the Northern Tier Pipeline Company)

This chapter summarizes, and where possible, quantifies those resources that would be consumed or otherwise lost if the proposal were implemented. The use of finite resources in a manner which precludes their use for other purposes is termed an irreversible and irretrievable commitment of resources. An irreversible commitment would be incapable of being reversed; once initiated, use would continue. An irretrievable commitment is essentially irrecoverable; once used, not readily replaceable.

7.1 Air Quality

Air quality and visibility would be irretrievably degraded during the life of the project, particularly in the Port Angeles area. Atmospheric conditions would allow pollutants to drift from the port over part of the Olympic National Park causing sulfur dioxide levels to exceed the allowable limits 3 or 4 days each year. This condition would be short-term but not irreversible. Periods of air quality degradation would be irretrievable, particularly in the immediate vicinity of the proposed port.

No irreversible or irretrievable commitments of air quality along the pipeline route would be anticipated.

7.2 Soils

Construction of the onshore storage facility at Green Point would irretrievably commit 140 acres for the life of the project. Soil use for plant propagation would be lost. Soils lost by wind and water erosion during construction would be irretrievably lost. Construction, operation, and maintenance of new pipeline and powerline maintenance roads, support facilities, runoff holding basins, and tank storage sites would cause a loss of soil productivity for the life of the project and for an undetermined length of time after abandonment.

Mixing of the soil profile would retard natural revegetation within the pipeline right-of-way. A slight, temporary reduction of soil productivity could be anticipated where new pipeline construction would cross agricultural areas, despite double-trenching techniques. Soil profiles within the trench and the areas of excavation would be permanently altered. Soils lost to erosion during construction, operation, or abandonment would be irretrievably lost.

Oil-Spill Risk

An oil spill could cause significant and irretrievable loss of soil productivity for several years. With time and careful rehabilitative efforts, soil productivity might be reestablished. The addition of high nitrogen nutrients to oil-contaminated soil along with tillage will allow soil microorganisms to break down the oil in 5 to 10 years.

7.3 Aquatic Resources

Construction of the onshore storage facility could result in an irretrievable loss of water quality in the perched aquifers at Green Point. Alteration of localized shallow aquifers would be an irreversible commitment of ground water resources.

Construction of the pipeline and related facilities would degrade water quality in numerous streams. Degradation would be largely short-term however, short term loss of quality would be irretrievable. Degradation of groundwater resources could last for several years. Associated with loss of water quality would be loss of fish spawning habitat which could be irreversible and extend beyond the life of the project. Reduced fish populations would be irretrievable.

Oil-Spill Risk

An oil spill affecting aquatic resources would lead to an irretrievable commitment of resources. In most cases the loss would be short-term. However, a longer irretrievable loss of water quality could occur if an oil spill contaminated ground waters. Degradation of water resources resulting in a loss of municipal, industrial, irrigation, or domestic uses would be of critical concern.

At critical times and locations, an oil spill could result in irretievable losses to resident and anadromous fish populations.

7.4 Marine Resources

The construction of the port and submarine pipelines would result in degradation of water quality in Port Angeles harbor. This loss would be of short duration, but the period of lowered water quality would be irretrievable. After abandonment, if the submarine pipes were salvaged, a similar degradation would be expected.

Construction and abandonment would also cause irretrievable loss of marine organisms within the harbor. However, while the system was in operation new populations of these organisms would be expected to repopulate disturbed areas.

Oil-Spill Risk

It would be expected that small chronic spills of crude and fuel oil from tankers and associated vessels would occur. These spills would result in an irretrievable reduction of water quality in a limited area of the harbor. Chronic small scale spills would also lead to an irretrievable loss of marine life in the immediate area of the berthing facilities.

A catastrophic accident involving crude oil tankers, fuel barges, or a break in the submarine pipelines would cause significant degradation of marine water quality. Restoration of water quality to pre-spill levels could be slow with a resulting irretrievable long-term loss of water quality. A catastrophic spill would also cause the irretrievable loss of marine life. However, that loss would be replaced in kind over the long term. A catastrophic spill in the Strait of Juan de Fuca would almost certainly degrade the shoreline of both the United States and Canada.

7.5 Terrestrial Vegetation

Construction of the onshore storage facility would result in the irretrievable loss of about 140 acres of forested land. This loss would be irreversible if the area were to be converted to other industrial or commerical uses following abandonment.

Construction of the pipeline would result in the irretrievable loss of forest resources for the duration of the project within the maintained right-of-way. In addition, irreversible losses of wetland vegetation would occur. Some wetland vegetation could be reestablished after abandonment.

Oil-Spill Risk

An oil spill could result in the irretrievable loss of vegetation. The loss of vegetation would be closely related to the irretrievable loss of soil quality. Complete vegetative reestablishment could occur along with soil recovery.

7.6 Terrestrial Wildlife

Construction of the onshore storage facility would result in the irretrievable loss of habitat for most wildlife in the Green Point area. A major irreversible loss would include the destruction of bald eagle wintering habitat. Operation of the onshore storage facility would preclude most wildlife repopulation at Green Point.

Construction of the pipeline would result in the irretrievable loss of wildlife habitat throughout its length, for the duration of the project. Following abandonment and subsequent revegetation, forest-wildlife habitat productivity could be expected to return to near preproject levels. Of particular concern would be loss of habitat currently used or suitable for bald eagles and black-footed ferrets.

Oil-Spill Risk

Oil spills and resulting cleanup efforts would be expected to result in the loss of individual animals because of oiling or toxicity and the loss of habitat. Small chronic spills would be expected to cause irretrievable loss of individual birds as they come in contact with the oil.

7.7 Cultural Resources

Each cultural resource site has unique and nonrenewable values. Known cultural resources affected by a project can often be salvaged before construction. However, even if salvaged, the loss of resource sites from the in-place resource base would constitute an irretrievable loss. Once construction is underway, cultural resources not previously identified could be partially or totally destroyed before the resource is recognized and construction stopped. Unrecovered materials would be an irreversible and irretrievable commitment.

Loss of paleontological resources would be similar to loss of archeaological and historic resources. Since many marine invertebrate fossils are abundant and widely distributed, the loss of some of them would not be particularly significant. In contrast however, many fossils occur rarely or are found only in localized distributions. Such fossils and their surrounding sediments may contain unique and valuable information about past environments and biological adaptions. The irretrievable loss of such resources could be significant.

Oil-Spill Risk

It is expected that damage to cultural resources would be minimal due to the relative scarcity of resource sites. If an oil spill were to occur in the vicinity of a site, it is probable that cleanup efforts would pose the greater threat. Use of machinery or hand tools could cause the irretrievable loss of cultural resources.

7.8 Visual Resources

Construction of the port and onshore storage facility would irreversibly alter visual resources of Port Angeles and Green Point. The presence of major new industrial facilities would irreversibly alter views of Ediz Hook. The pipeline extending up to the onshore storage site would cause a visible scar at the Green Point sea bluff. The scar would be visible for miles on the seaward side and would be a major irretrievable loss of visual resources. The 11 storage tanks at the Green Point site would be an irreversible visual intrusion.

Construction of the pipeline and related facilities would result in the irretrievable loss of visual resources across the entire route of the pipeline excepting agricultural and rangelands. The visual contrast would be the greatest and irreversible through forested lands and at the four delivery facility sites.

Oil-Spill Risk

A marine oil spill could result in major degradation of visual resources in the Port Angeles area. The extent of visual degradation could be extensive with possible loss of visual resources extending along several miles of shoreline.

7.9 Land Use, Transportation, and Utilities

Construction of the port facility would preclude use on several acres on Ediz Hook and in the harbor. Other industrial uses, including log storage, would be precluded. The port facility would also be an irretrievable intrusion on the Coast Guard Air station. Relocation of the VOR installation would be necessary. Following abandonment and removal of the port facility, the land would be available for other uses.

Construction of the onshore storage facility would cause the loss of most of 140 acres of low to moderate quality commercial forest land. It would preclude potential uses, including residential development. These losses would probably be permanent because other industrial or intensive use would be expected to follow abandonment.

The pipeline right-of-way, pump station sites, and powerline rights-of-way represent irreversible land-use commitments for the life of the project. In some areas these installations would restrict expansion of irrigated agriculture, timber production, and transportation or utility corridors. Given increasing environmental difficulty of routing utilities, it is likely that, if abandoned, the pipeline corridor would be converted to another utility or transportation corridor rather than reverting to preproject uses. Thus, the corridor would likely remain for the long-term.

Oil-Spill Risk

Major impacts from oil spills on land uses and transportation and utility networks would be expected to be short-term disruptions. Productivity of agricultural lands could, however, be seriously degraded for up to 10 years with reclamation efforts. Productivity would be degraded indefinitely without reclamation efforts.

7.10 Recreation

Construction of the proposed pipeline would cause irretrievable losses in certain areas of recreational resources. The cleared right-of-way and access roads would irreversibly change areas valued for beauty, solitude, or other natural qualities. Displacement of wildlife or loss of fishery resources would also irretrievably affect recreation activities. Maintained corridors could increase hunter pressure and irretrievably commit previously remote areas to general recreation use.

Oil-Spill Risk

Oil spills and resulting cleanup efforts would result in the irretrievable loss of recreational opportunities in both the United States and Canada. In most instances the loss would be of short term. However, loss of fishery or marine resources could have an irreversible effect on both commercial and sport fisheries.

7.11 Social and Economic Conditions

The proposed construction and operation of the port and onshore storage facilities would result in major irretrievable and irreversible changes in the city of Port Angeles and in Clallam County. An oil port would be the first major contributor to the local economy not reliant on locally produced natural resources. To many residents in the area, the project's construction would irretrievably decrease the quality of life.

During construction, operation, or abandonment, loss of life or limb from accidents would be irretrievable.

If the crude oil delivery system from the tanker unloading facility on Ediz Hook to storage tanks at Green Point were fully developed, the system would irreversibly commit approximately 14 miles of 48-inch or 52-inch steel pipe in submarine pipelines. Approximately 71,000 tons of steel used in constructing the port and onshore storage facility would likewise be irreversibly committed. A major portion of this steel could be salvaged upon termination of the project. Non-salvageable steel and other natural resources would be irretrievably lost, including 35,625 cubic yards of sand, gravel, and cement used in making concrete; an undetermined volume of select fill; 18 tons of copper; and 378,000 board feet of lumber.

Along the pipeline route, construction, operation, and abandonment would result in irretrievable changes in many small communities. For the most part these changes would be short-term during the construction stage. The project would probably result in long-term commitments of existing refineries in market areas to the continuation of their refining operations.

Construction of the pipeline would commit about 707,000 tons of steel including the pipe, storage tanks, and support equipment. The steel in some of these items would be reclaimable upon the termination of the project. In addition, natural resources committed to the construction and conversion of the project would be irretrievably lost, including 16,316 cubic yards of sand, gravel, and cement used in concrete, 109,000 cubic yards of select fill; 206 tons of copper; 491,000 board feet of lumber; and unknown quantities of water and fuel.

Implementation of the project would irretrievably commit approximately 6,740 workers for various periods of time during the construction phase. Construction would require the equivalent of approximately 4,900 man-years of labor in direct employment. Indirectly the project would irretrievably commit the equivalent of 5,000 jobs and 500,000 man-hours of work in the steel industry for manufacturing steel for the pipe and the storage tanks. Once construction was finished, permanent employment of 143 persons would be irretrievably committed to operate the system for the 20-year project life.

Additional unknown numbers of workers could be committed to assess, mitigate, or compensate for project impacts.

The commitment of power during operation would be substantial. Table 7.11-1, shows the crude oil to be delivered annually at different delivery rates and the annual electric power requirements for operating the port facility and the pump stations.

TABLE 7.11-1 ENERGY DELIVERED VS ELECTRICAL ENERGY USED
(Annual)

	Rates of Crude Oil Delivery	
	709,000 bpd	933,000 bpd
Amount of crude oil delivered	259 MM barrels	341 MM barrels
Electric power requirements for the marine terminal and pumping stations	1025 MM KWH	2062 MM KWH
Energy efficiency (ratio of BTUs transmitting the crude to the BTUs transported)*	0.24%	0.37%

Source: DOE 1979
*Based on 5,571,500 BTUs per barrel of crude and 3,412 BTUs per kilowatt hour of power. (Equivalents derived from DOE 1979).
bpd = barrels per day
MM = Million
MM KWH = Million kilowatt hours

Table based on operating 365 days per year.

Oil-Spill Risk

A major oil spill would result in the irretrievable commitment of human and material resources for cleanup efforts. A spill could cause an irretrievable decrease in the quality of life in Port Angeles because of the importance of the marine environment to the local community. A degradation of the human environment through contamination and loss of life or limb from fire or explosion would be irretrievable and irreversible losses.

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